## *United States Court of Appeals*
## *for the*
## *District of Columbia Circuit*

# TRANSCRIPT OF RECORD

# No. 10,683

## JOINT APPENDIX

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In The

# United States Court of Appeals

For the District of Columbia Circuit

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Herbert C. Otis, *Appellant*,

vs.

John A. Marzall, Commissioner of Patents, *Appellee*.

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**Appeal from a Judgment of the United States District Court for the District of Columbia**

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United States Court of Appeals
For the
District of Columbia Circuit

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# United States Court of Appeals

For the District of Columbia Circuit

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No. 10,683

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Herbert C. Otis, *Appellant*,

vs.

John A. Marzall, Commissioner of Patents, *Appellee*.

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**Appeal from the United States District Court for the District of Columbia**

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## JOINT APPENDIX

219 Filed Jan 19 1948 Harry M. Hull, Clerk

IN THE DISTRICT COURT OF THE
UNITED STATES FOR THE
DISTRICT OF COLUMBIA
HERBERT C. OTIS,
Dallas, Dallas County, Texas,
Plaintiff
vs.
LAWRENCE C. KINGSLAND
and or the Successor in Office
Commissioner of Patents,
United States Patent Office
Washington, D. C.
Defendant
Civil Action No. 233-'48

## *Bill of Complaint*

1. The plaintiff, HERBERT C. OTIS, is a citizen of the United States and resident of Dallas, County of Dallas, and State of Texas.

2. The defendant, LAWRENCE C. KINGSLAND, is the Commissioner of Patents of the United States, a legal resident of the District of Columbia and is sued as Commissioner of Patents of the United States.

3. This action arises under Section 4915, Revised Statutes (Comp. Stats. 9460; U. S. C. Title 35, Section 63), as amended. No appeal has been filed in the United States Court of Customs and Patent Appeals under Section 4911 Revised Statutes (U. S. C. Title 35, Section 59a).

4. On the 28th day of January, 1943, the plaintiff, HERBERT C. OTIS, with JOHN C. LUCCOUS as co-inventor, duly filed an application for patent in the United States Patent Office entitled "WELL FLOW REGULATING APPARATUS" and given Serial No. 437,838; the undivided interest of the said JOHN C. LUCCOUS being

assigned to the said HERBERT C. OTIS as evidenced
220 by a duly executed assignment recorded in
the United States Patent Office January 28, 1943,
Liber V194, Page 434.

5. The aforesaid application, Serial No. 437,878, was filed as a continuation-in-part of co-pending applications, Serial No. 288,004, filed August 2, 1939, and Serial No. 329,064, filed April 11, 1940.

6. In an action dated July 2, 1946, the Primary Examiner finally and unjustly refused to allow the claims in the aforesaid application, Serial No. 437,838, said claims being numbered 36 through 66.

7. The plaintiff appealed from the action of the Primary Examiner to the Board of Appeals of the United States Patent Office upon claims 36, 38 through 41, 44, 46, 48 through 57, 59 through 62, 65 and 66 of the aforesaid application.

8. In a decision rendered July 23, 1947, the Board of Appeals reversed the decision of the Primary Examiner as to claims 38 and 51 through 55 but unjustly affirmed the final rejection of claims 36, 39 through 41, 44, 46, 48 through 50, 56, 57, 59 through 62, 65 and 66, said rejected claims appearing in Schedule A attached hereto and made a part hereof.

9. In a decision dated December 8, 1947, the Board of Appeals denied the plaintiff's petition for reconsideration and unjustly refused to change its previous decision.

10. The defendant erred in contending that, in view of the Bruce patent No. 1,199,152, it would not involve the exercise of the inventive faculties to substitute the automatic valve of Bruce for the manually operated valve or bottom hole choke of the well control device shown by
the Knowlton et al patent No. 1,905,592, and in rejecting
221 claims 36, 39, 56, 57, 59 through 62, 65 and
66 on this ground.

11. The defendant erred in affirming the rejection of

claims 40, 41, 49 and 50 on the valve structure shown in the Bruce patent No. 1,199,152.

12. The defendant erred in affirming the rejection of claims 46 and 48 as not being patentable over the Bruce patent in view of the Otis patent No. 1,920,103 and in holding that anyone skilled in the art could substitute a valve of the type shown by Bruce for the valve in the Otis well tool.

13. The defendant erred in rejecting claim 44 as unpatentable over the Bruce patent in view of the Otis patent No. 1,920,103.

14. The defendant erred in rejecting claims 46 and 48 upon the Bruce patent.

WHEREFORE, the plaintiff prays that this Honorable Court adjudge that he, the plaintiff, is entitled to receive a patent with the claims of Schedule A, or such other or modified claims as the Court may find patentable, and that this Court authorize the defendant to issue such patent to the plaintiff.

/s/ William T. Geier
William T. Geier
Attorney for Plaintiff
Munsey Building
Washington, D. C.

* * * *

222 Filed Jan 19 1948 Harry M. Hull, Clerk

233-'48

## *Schedule A*

36. In a fluid pressure regulator for the fluids of a flowing well having tubing therein, the combination with a surface control for regulating the rate of withdrawal of well fluids from the tubing, of a body provided with means for mounting it in a well tubing upstream of the surface control and having a flow passage therethrough, valve members in the body for controlling the flow of well

fluid through the passage of said body at a predetermined substantially constant pressure reduction, one of said valve members being movable toward and from the other valve member, and means constantly urging said movable valve member toward the other valve member to automatically regulate the flow past the valve members in response to adjustments of the surface control to create and to maintain said predetermined substantially constant reduction in the pressure of the fluid flowing past said valve members.

39. Means for controlling the flow of a well when the rate of withdrawal and/or the pressure of the fluid discharged from the well is varied which includes, means at the top of the well for controlling the rate of withdrawal of fluid from the well, and flow regulating means in the well below the upper end thereof cooperating with the controlling means at the top of the well, said regulating means including valve elements, one of which is movable with relation to the other valve element and responsive to fluid pressure differences above and below said elements to control the flow of well fluids past said regulating means, said flow regulating means also including a resilient member acting upon the movable valve element to automatically adjust said valve element to regulate the flow and to create and maintain a predetermined 223 substantially constant pressure reduction in the fluid flowing past the flow regulating means when the control means at the top of the well is operated to vary the rate of withdrawal of well fluid.

40. A well fluid flow regulator including, a tubular body adapted to be located in a well and having a flow passage therethrough, a valve seat element in the body having a flow passage communicating with the flow passage of the body, a valve flow restricting element in the body acting with the seat element to regulate flow upwardly of the well fluid through the body, one of the valve elements being movable toward and from the other

valve element and having uncovered opposite areas exposed to direct contact with the well fluid flowing through the passage of said body, whereby fluid pressures below and above said movable valve element are directly exerted thereon, and means acting on the movable valve element to resist movement of said element to create a predetermined flowing pressure differential thereacross, said resisting means acting to automatically adjust the movable valve element to regulate flow through the valve seat to maintain a substantially predetermined pressure reduction across the valve elements when the rate of withdrawal of well fluid flowing through the body is varied.

41. A well fluid flow regulator including, a tubular body adapted to be located in a well and having a flow passage therethrough, a valve seat element in the body having a flow passage therethrough, a valve element disposed in the body to act with the seat element to regulate the flow of well fluid through the passage thereof, one of said valve elements being movable and having upwardly and downwardly facing areas exposed to direct upward and downward pressure exertion of the fluid flowing past said elements, and resilient means acting on the
224 movable valve element to urge said movable valve
element toward the other valve element to automatically regulate flow of well fluid through the passage of the seat element to create and maintain substantially a fixed predetermined pressure reduction across said valve elements when the rate of withdrawal of well fluid flowing through the body is varied.

44. In a well flow regulating device, the combination of an adjustable anchoring device provided with a well fluid passage therethrough and having anchoring means and external packing for directing flow of well fluids through the flow passage, and a well fluid flow regulator carried by the anchoring device and having a well fluid flow passage communicating with the flow passage of said anchoring device and also having valve means responsive

to differences in fluid pressures in the flow passage on the upstream and downstream sides of said regulator for automatically creating and maintaining a predetermined substantially constant reduction in pressure of the fluid flowing past said regulator during variations in such flow.

46. A pressure regulator for wells including, a tubular body having means for anchoring it in a well tubing and having an axial bore, a stationary valve member mounted within the body, a valve sleeve having a flow passage extending therethrough mounted within the bore of the body and movable with relation to the valve member, the upper end of the sleeve being exposed to the fluid pressure within the tubing thereabove and its lower end exposed to the fluid pressure within the tubing therebelow, and resilient means for urging said valve sleeve toward the stationary valve member to regulate fluid flow through the body and to create and maintain a substantially constant predetermined pressure differential across said sleeve.

225 48. A pressure regulator for wells including, a tubular body having means for anchoring it in a well tubing and having an axial bore, a stationary valve member mounted within the body, a valve sleeve having a flow passage extending therethrough mounted within the bore of the body and movable with relation to the valve member, means for packing off between the valve sleeve and the bore of the body to direct fluid flow through the passage of the sleeve and to cause the fluid pressures above and below said sleeve to act against the opposing areas thereof, a coiled spring surrounding the sleeve and confined within the body for urging said sleeve toward the stationary valve member to restrict flow through the sleeve to create and maintain a substantially constant predetermined reduction in pressure of fluid flowing through the sleeve, and means removably mounted within the device for adjusting the compression of said spring to vary the pressure reduction created across the sleeve.

49. A well fluid regulator for a flowing well including, a body having a well fluid inlet and a flow passage upwardly therethrough from the inlet, valve members in the passage of the body for controlling upward flow of well fluid through said passage, one of said valve members being movable toward and from the other valve member and having opposite ends exposed to fluid pressures acting upwardly and downwardly, and resistive means urging the movable valve member toward the other valve member to create and maintain a predetermined substantially constant pressure difference across said members and to cause the movable valve member to automatically respond to the pressure difference across the valve members to regulate the flow through the body between said valve members.

50. A well fluid flow regulator adapted to be
226 mounted in a well including, a tubular body having means for securing it in a well tubing below the surface of the well and provided with a flow passage therethrough, a valve member mounted within the body, means holding said valve member normally stationary in said body, a tubular valve sleeve slideable within the passage of the body and movable with relation to the valve member, the sleeve having its upper end exposed to fluid pressure thereabove and its lower end exposed to fluid pressure therebelow, and means yieldably urging said sleeve toward the valve member to regulate flow through the body to create and maintain a substantially constant predetermined pressure differential across the sleeve, said normally stationary valve member being movable away from the sleeve to permit a downward flow therethrough.

56. In an automatic flow pressure regulator for the eduction tubing of a well, the combination with a surface control for regulating the withdrawal of the well fluids from the tubing, of a body adapted to be inserted in the tubing upstream of the surface control and having means for mounting it in such tubing, the body also having a well fluid flow passage adapted to conduct well fluids

therethrough, and valve means in the body exposed to upstream and downstream fluid pressures and set to automatically yield to differences in such pressures of the well fluid flowing past said valve means to regulate the flow of such fluid through the passage of the body to automatically create and maintain a predetermined pressure reduction across said valve means during variations in withdrawal of well fluid responsive to flow regulating adjustments of the surface control.

57. Means for varying the withdrawal of well fluids from the eduction tubing of oil and gas wells which includes, a surface control having an adjustable with-
227 drawal outlet and connected with the upper end of
the tubing, valve means in the well upstream of the surface control and automatically movable in response to fluid pressure differentials thereacross to maintain a predetermined pressure reduction in the well fluid flowing past said valve means, and resilient means set to regulate movement of the valve means in response to variations in the rate of withdrawal through the surface control to maintain substantially constant the predetermined pressure reduction in well fluids flowing through the valve means.

59. Means for controlling the flow of fluids from a well including, a surface control for varying the withdrawal of well fluids from the well, and regulating means in the well flow stream spaced upstream from said surface control and including valve members, one member being movable with respect to the other member and exposed to differences in fluid pressures on its upstream and downstream sides, and pressure exerting means urging said movable valve member toward the other valve member to automatically regulate flow past said members to create and maintain a substantially constant predetermined reduction in the pressure of the fluids flowing past said regulating means during variations in withdrawal of well fluids as controlled by the surface control.

60. Means for controlling the flow of fluids from a well having an inlet and an outlet including, valve means for controlling withdrawal of fluid from the well outlet, and regulating means responsive to differences in fluid pressures on its upstream and downstream sides disposed between the well inlet and said valve means for automatically creating and maintaining a predetermined substantially constant reduction in pressure of the fluid flowing past said regulating means during variations in withdrawal of fluid from the well as controlled by said valve means.

228 61. Means for controlling the flow of fluids from a well including, valve means at the well surface for controlling the flow of fluid from the well, and a plurality of spaced pressure responsive means disposed upstream of the valve means for automatically maintaining a predetermined reduction in pressure of the fluid flowing therepast to said valve means.

62. Means for controlling the flow of fluids from a well including, valve means at the well surface for controlling the flow of fluid from the well, and a plurality of spaced pressure responsive means disposed upstream of the valve means for automatically maintaining a predetermined reduction in pressure of the fluid flowing therepast to said valve means, said spaced pressure responsive means being set to each maintain a substantially constant portion of the predetermined pressure reduction on the flowing fluid.

65. A well fluid flow apparatus including, a well flow tubing, a device connected in the tubing having a valve seat and a flow member movable toward and from said seat to shut off flow through the tubing and to permit flow through said tubing, said member having substantially equal effective areas at each end exposed to the well fluid pressures thereabove and therebelow, fluid-pressure responsive means responsive to pressure differentials above and below said member when said member is moved

away from its seat for automatically adjusting said member in accordance with the rate of flow through the device to maintain a fixed pressure drop thereacross regardless of variations in the rate of such flow, and means connected in the tubing beyond the device adjustable for controlling the rate of withdrawal of well fluid through the tubing and said device, the device being automatically responsive to adjustments of said means.

229 66. The system of controlling the flow of high pressure wells therein the flowing well fluid contains gas which includes, a flow tubing having a portion disposed in the well, a control device connected in the tubing and having means adjustable to regulate the rate of withdrawal of well fluid from the tubing, and a valve device connected in the tubing between the producing formation and the control device including a valve seat and a valve member movable to and from said seat in the path of the flowing fluid, and means for urging the valve member toward the seat responsive to fluid pressure differentials across the valve device, whereby variable flow restrictive areas between said member and its seat are set up, the movable valve member being automatically responsive to adjustments of the control device and variations in the pressure of the fluid flowing from the formation to set up a restrictive flow area in accordance with adjustments of said control device and variations in the formation flowing pressure to maintain a substantially fixed pressure drop across the valve device irrespective of variations in the rate of withdrawal of well fluid from the tubing.

* * * *

230 Filed Mar 5 1948 Harry M. Hull, Clerk

*Answer to the Complaint.*

To the Honorable the Justices of the District Court of the United States for the District of Columbia.

1. Defendant admits the allegations of paragraph 1.

2. He admits the allegation of his official position and that he is sued in his official capacity. He states that his official residence is in the District of Columbia.

3. He admits the allegations of paragraph 3.

4, 5. He admits the allegations of paragraphs 4 and 5, except the allegation that plaintiff's application, which was filed on January 28, 1943, was given Serial No. 437,838 or 437,878. This allegation he denies. He states that said application was given Serial No. 473,838.

6. He admits that on July 2, 1946, the primary examiner finally refused to allow claims 36 to 66, inclusive, of said application. He denies, for reasons hereinafter given, that said refusal was unjust.

231 7. He admits the allegations of paragraph 7.

8. He admits that on July 23, 1947, the Board of Appeals of the Patent Office reversed the decision of the primary examiner as to claims 38 and 51 to 55, inclusive. He admits that in said decision the Board of Appeals affirmed the final rejection of claims 36, 39 to 41, inclusive, 44, 46, 48, 49, 50, 56, 57, 59 to 62, inclusive, 65 and 66. He denies that the decision of the Board of Appeals was unjust in affirming the rejection of said claims.

9. He admits that in a decision dated December 8, 1947, the Board of Appeals denied plaintiff's petition for reconsideration and refused to change its previous decision. He denies that this action of the Board of Appeals was unjust. He states that said claims, as to which the examiner's action was affirmed by the Board of Appeals, are unpatentable in view of the following prior patents and for the reasons given in the Examiner's statement and in said decisions of the Board of Appeals:

| | | |
|---|---|---|
| Bruce, | 1,199,152, | Sept. 26, 1916, |
| Nichols, | 1,637,085, | July 26, 1927, |
| Knowlton et al., | 1,905,592, | April 25, 1933, |
| Otis, | 1,920,103, | July 25, 1933, |
| Otis, | 1,972,791, | Sept. 4, 1934. |

Profert of copies of these patents is hereby made.

10, 11, 12, 13, 14. He denies the allegations of paragraphs 10 to 14, inclusive.

/s/ W. W. Cochran
Solicitor, U. S. Patent Office,
Attorney for Defendant.

March 5, 1948.

233 Filed Apr 21 1948 Harry M. Hull, Clerk

* * * *

*Motion to Amend Complaint*

Plaintiff moves the Court for leave to amend his complaint on file herein in the following particulars.

1. Amending Paragraph 4 to read as follows:

On the 28th day of January, 1943, the plaintiff, HERBERT C. OTIS, with JOHN C. LUCCOUS as co-inventor, duly filed an application for patent in the United States Patent Office entitled "WELL FLOW REGULATING APPARATUS" and given Serial No. 473,838, the undivided interest of the said JOHN C. LUCCOUS being assigned to the said HERBERT C. OTIS as evidenced by a duly executed assignment recorded in the United States Patent Office January 28, 1943, Liber V194, Page 434.

2. Amending Paragraph 5 to read as follows:

The aforesaid application, Serial No. 473,838, was filed as a continuation-in-part of co-pending applications, Serial No. 288,004, filed August 2, 1939, and Serial No. 329,064, filed April 11, 1940.

3. Amending Paragraph 6 to read as follows:

In an action dated July 2, 1946, the Primary Examiner finally and unjustly refused to allow the claims in the aforesaid application, Serial No. 473,838, said claims being numbered 36 through 66.

234 The foregoing amendments merely involve the corrections of typographical errors. As noted in defendant's answer, the serial number of plaintiff's application is incorrectly set forth in the complaint. No ob-

jection has been raised by defendant as to the sufficiency of the amended paragraphs and no further response or answer is required by the amendments.

/s/ William T. Geier  
William T. Geier  
Attorney for Plaintiff  
458-9 Munsey Building  
Washington, D. C.

* * * *

235 Filed May 4 1948 Harry M. Hull, Clerk

*Order Granting Leave to Amend*

This cause came on to be heard on plaintiff's motion for leave to file his complaint, and it appearing that justice requires that such leave be given, and the Court being fully advised:

It is Ordered:

That plaintiff be given leave to amend his complaint.

/s/ T. Alan Goldsborough  
United States District Judge

* * * *

236 Filed May 6 1948 Harry M. Hull, Clerk

* * * *

*Answer to Amended Complaint*

To the Honorable the Justices of the District Court of the United States for the District of Columbia.

Defendant reaffirms the answers made on March 5, 1948 to paragraphs 1, 2, 3 and 7 to 14, inclusive, of the Complaint.

4 and 5. He admits the allegations of amended paragraphs 4 and 5.

6. He admits that on July 2, 1946 the primary examiner finally refused to allow claims 36 to 66, inclusive, of plaintiff's application Serial No. 473,838. He denies, for

reasons given in his previously filed answer to para-
237 graph 9, that said refusal was unjust.

s/ /W. W. Cochran
Solicitor, U. S. Patent Office,
Attorney for Defendant.

243 Filed Dec 5 1949 Harry M. Hull, Clerk

* * * *

*Order.*

Upon consideration of the fact that John A. Marzall succeeded to the office of Commissioner of Patents on December 2, 1949, in place of Lawrence C. Kingsland, who resigned, and it appearing that there is substantial need for continuing and maintaining the above-entitled action, now therefore it is this 5th day of December 1949

ORDERED, that John A. Marzall, Commissioner of Patents be and he is hereby substituted as party defendant in place of Lawrence C. Kingsland, formerly Commissioner of Patents.

/s/ Jennings Bailey
Judge.

* * * *

244 Filed Jan 3 1950 Harry M. Hull, Clerk

The plaintiff has brought this suit seeking to have the Court authorize the defendant, The Commissioner of Patents, to issue to him patent embracing certain claims for improvements in devices for regulating fluid flow in high pressure oil wells, especially where the ratio of gas to oil is high or where the fluid is substantially all gas; the invention consisting of improvements in fluid flow regulating devices arranged to be placed and anchored within the well tubing, and the combination of this fluid flow regulating devices with an adjustable surface control device connected to the upper end of the well tubing. The Knowlton Patent 1,905,592 teaches the combination of a surface control with a fluid flow regulating structure in the conventional well tubing below the surface control. The plaintiff has substituted an automatically fluid pressure control for the regulating structure shown in the Knowlton patent. The type of valve control employed by plaintiff is shown in the Bruce patent 1,199,152. The plaintiff claims, however, that the Bruce device is not suitable for the high pressure usually found in oil and gas wells and is suitable only in internal combustion engines, but it would seem that the Bruce device could well be adapted for oil pressure wells by an ordinarily skilled mechanic.

The examiner in the Board of Appeals of the Patent Office rejected plaintiff's claims, in view of the foregoing patents and cited other patents also.

245 Without repeating the substance of the opinion of the Board of Appeals of the Patent Office, it is suffice to say that I agree with it especially in view of the Knowlton and Bruce patents, nor is my opinion affected by the testimony introduced before me.

The complaint will be dismissed.

/s/ Jennings Bailey
Judge

* * * *

246 Filed Mar 7 1950 Harry M. Hull, Clerk

*Findings of Fact*

1. This is an action under Section 4915 of the Revised Statutes (U. S. C., title 35, sec. 63) in which the plaintiff, Herbert C. Otis, sought to have the Court authorize the issuance of a patent to him containing claims 36, 39, 40, 41, 44, 46, 48, 49, 50, 56, 57, 59, 60, 61, 62, 65, and 66 of his application No. 473,838 for patent on a valve mechanism for use in controlling the flow of well fluids.

2. The plaintiff's application here involved discloses a fluid well system in which a manually adjustable valve is located in the outlet pipe, adjacent the ground level,

and an automatic valve is placed in the outlet pipe
247 near the bottom of the well. The automatic valve
comprises a fixed valve element and a sleeve, connected to and communicating with the outlet pipe and movable toward and from the valve element to regulate the flow of fluid into that pipe. The sleeve is urged toward the valve element by a spring and is exposed on its upper end to the pressure in the outlet pipe and on its lower end to the pressure of the fluid in the well. The valve mechanism acts to maintain a constant difference between the pressure immediately above and the pressure immediately below the valve, regardless of the well pressure or the extent of opening of the manual valve at the surface.

3. The patent to Knowlton et al No. 1,905,592 discloses a control system for fluid wells comprising a manually operable valve located in the outlet pipe at the ground level and a second valve, located in the outlet pipe near the bottom of the well and manually controlled from the ground level. The patent states that the arrangement disclosed "makes it possible to obtain a pressure differential between the well and the inside of the tubing ranging from zero to the maximum formation pressure".

4. The patent to Bruce No. 1,199,152 discloses an automatic flow regulating valve comprising a casing containing a fixed tapered projection and a movable piston member having an opening surrounding the projection,
248 so that the movement of the member varies the size
of the fluid passage between it and the projection. The movable member is urged by a spring toward valve-closing position and is acted upon on one side by the fluid entering the casing and on the other side by the fluid which is leaving the casing after passing the valve. The arrangement thus provided serves to maintain a constant differential in pressure between the inlet and outlet ends of the casing. The device is shown only in connection with an internal combustion engine for admitting supplementary

air from the atmosphere into the intake manifold in accordance with changes in the degree of vacuum existing in the intake manifold from time to time, but is said to be useful for regulating the flow of "all fluids".

5. The patent to Otis, No. 1,920,103 discloses a choke device having a restricted passage which device may be lowered into and anchored in a fluid well to produce a pressure drop for a predetermined constant rate of flow in the outlet pipe. The device may be removed and replaced by another having a passage of a different size, if it is desired to produce a different pressure drop. The exchange of restrictions requires extensive operations while the well is shut in, as fully set forth in the patent.

6. The Knowlton et al patent discloses the combination, in a fluid well, of a surface regulating valve and an 249 adjustable valve at the bottom of the well for maintaining a desired differential between the fluid pressure in the well and that in the outlet pipe.

7. The valve shown in the Bruce patent is of general application and could be readily adapted by a skilled mechanic for use in a fluid well.

8. It would not require invention to replace the manually operated valve used by Knowlton et al at the bottom of the well by an automatic valve of the type shown by the Bruce patent.

9. The use of two or more valves such as that shown by the Bruce patent in a fluid well would be an obvious duplication involving no invention.

10. The claims set forth in the complaint do not define anything involving invention over the prior art.

11. The claims set forth in the complaint are unpatentable in view of the prior art.

## *Conclusions of Law*

1. Plaintiff is not entitled to a patent containing any of the claims set forth in the complaint.

2. The complaint should be dismissed as to all the claims involved.

Jennings Bailey,
Judge.

January , 1950.

250 Filed Mar 7 1950 Harry M. Hull, Clerk

* * * *

## *Judgment*

This action came on to be heard at the last term and thereupon, upon consideration thereof, it is this 7th day of February, 1950,

ADJUDGED that the complaint in this case be, and the same hereby is dismissed with costs against the plaintiff.

/s/ Jennings Bailey,
Judge.

Approved as to Form:
George Rex Frye,
Attorney for plaintiff.

* * * *

251 Filed May 5 1950 Harry M. Hull, Clerk

## *Notice of Appeal*

Notice is hereby given that Herbert C. Otis, plaintiff above named, hereby appeals to the United States Court of Appeals for the District of Columbia from the final judgment entered in this action on March 7, 1950.

/s/ George Rex Frye
George Rex Frye
Attorney for Appellant
Herbert C. Otis
913 Kass Bldg.
Washington, D. C.

13 *Lester T. Potter*

* * * *

14 *Direct Examination*

BY MR. BROWNING:

Q You are Mr. Lester T. Potter, of Dallas, Texas? A Yes, sir, I am.

Q And you are at present the assistant to the president of the Lone Star Gas Company, located at Dallas, Texas? A Yes, sir.

Q And you were formerly superintendent of production for that company? A That is correct.

Q How would you rank the Lone Star Gas Company in size as among other gas companies in the same general line of business? A It is one of the larger companies, Mr. Browning. It is in a sense local in that it operates only in the States of Texas and Oklahoma, but it does operate a large system.

Q From how many wells does it take gas, approximately? A On the order of a thousand.

Q Would you say it takes from a thousand wells both directly and indirectly? A Well, if you include wells from which it obtains gas indirectly, the number would be much larger.

Q By approximately how much? A Four or five hundred.

15 Q You are a registered engineer and have been for approximately 21 years; is that right? A Yes, sir. Well, I have not been a registered engineer that long, Mr. Browning. I have been doing engineering work about that long, but I have been registered only since the time it was first required by the State of Texas.

Q In other words, since the registration law was passed by the State of Texas? A That is correct.

Q During that 21 years you have been engaged in the practice of petroleum and natural gas engineering and had occasion to deal with the engineering problems involved in that field? A Yes, sir, I have.

Q You are a graduate of Texas A. & M. College? A Yes, sir.

Q And you received the degree of BSME in 1928? A That is right.

Q State the various jobs and positions you have held since your graduation from engineering college and approximately the time you held each job. A I was engaged continuously in production work until about two and a half years ago.

Q For what company? A For the Lone Star Gas Company.

16 During that interval I was engaged during the first 15 or 16 years in work generally referred to as production engineering, and during that interval of time I held the posts of production engineer, assistant chief production engineer, chief production engineer, and subsequently thereto superintendent of production.

Q What was your first duty with the Lone Star Gas Company? A The first assignment I had, Mr. Brown'ing, was in connection with the installation and operation of what we called gas well siphons. I was concerned with the operation of these devices installed in gas wells for a period of some months after my first employment.

Q What was the purpose of these gas well siphons? A The primary purpose was to remove salt water that is produced in many gas wells along with the gas in order that the salt water might not collect in the well bore and drown out the gas.

Q In connection with your work as an oil and gas production engineer, have you had occasion to deal with the matter of reducing pressures of oil or gas as produced from a well for the purpose of dealing with the oil and gas at the surface of the ground, either by treatment thereof or by turning it into a pipeline for
17 transmission to another location? A Yes, sir, I have.

Q Have you had any problems having to do with freezing in connection with such reduction of pressures? A Yes, sir, I have.

Q Has that problem of avoiding freezing in the reduction of pressures of gas been a more or less recent problem or has it been of long standing? A It has been a continuing problem, Mr. Browning; certainly within my own experience and, as a matter of fact, before that.

It has been an increasing problem in the sense that wells have been drilled progressively deeper, causing the necessity of contending with increasing pressures over the years at the wellheads. So that the matter of freezing has been one of the pressing problems in the production end of the business over the years.

Q You say ever since you have had experience with the production of gas. What years would that be? A Since 1928.

Q That was upon your graduation from Texas A. & M. College, when you went to work with the Lone Star Gas Company? A That is correct; yes, sir.

Q Were you ever personally concerned with trying to
solve the problem of freezing or obtaining some
18 means for its solution? A Yes, sir; I was.

Q And did you ever, prior to 1939, find any completely satisfactory solution to that problem? A Yes, sir, I can say I did.

Q Will you tell us what that was? A The first satisfactory solution which had a limited application was in the case of those gas wells which could be produced wide open through a small string of tubing, that is, such as utilized in the gas well siphon I mentioned a moment ago.

As long as the well could be produced wide open through the tubing, the freezing problem was minimized, and in some cases practically eliminated.

And the next solution which had much wider application which we were able to take advantage of, was the so-called fixed bottom hole choke.

Q You spoke of the limitations of those solutions. What are the chief limitations that you had reference to? A The chief limitation, I believe, Mr. Browning, was the fact that in the operation of either of the devices I have mentioned, the operation was limited practically to one and only one rate of flow from the well. It wasn't suitable for substantial variation in the flow.

Q Is it frequently or is it not frequently desir-
19 able to vary the flow from the well? A It is de-
sirable, and in many cases, I would say, it is mandatory because there are few, if any, requirements placed upon a gas well that are not varying in character.

Q And what steps have been taken in the past, other than by control of the flow down in the well, for the purpose of combatting this freezing if there had been any? A Well, very often other steps were taken or attempted, the first of which I was familiar and had direct contact, was a most complicated system of chokes set in series at or near the wellhead with intervening drips or cooling spots, on the theory of making a pressure reduction in a series of steps in such a way that freezing might be avoided. That device was never successful to any point of satisfaction.

Another device that has been utilized was one of applying heat to the surface equipment at some point, either ahead of or at the point where freezing would be expected, so as to raise the temperature and avoid the freezing and stoppage.

Q You spoke of a bottom hole choke a while ago. Do you know whether or have you seen any patent that illustrates that bottom hole choke? A Yes, sir, I have.

Q Do you know whether it is one of the patents that
is cited in the answer in this case? A I don't know
20 whether it is cited or not. I believe I was so in-
formed. I have seen and read the patent, and I am familiar with it.

Q Would you recognize it if you saw it? A I think I would; yes, sir.

Q I show you a print of the patent to H. C. Otis. It is number 1,920,103.

I ask you if you recognize anything shown on that print. A Yes, sir, I think I recognize that as the instrument to which I referred as the fixed bottom hole choke.

Q Now, in the use of this fixed bottom hole choke, what will be the result if you attempted, let us say, by closing off partially the flow from the well at the top of the well in order to reduce the amount of production of the well? A If you did that, Mr. Browning, you would effectively eliminate the usefulness of the bottom hole choke because you would have transferred that point of restriction from the location of the bottom hole choke to the surface control valve.

Q What will be the effect of eliminating the bottom hole choke in that fashion? A You would have the same conditions conducive to freezing at the surface again.

Q What will be the effect on the pressures existing
above the bottom hole choke if you pinched down
21 on the flow? A They would build up.

Q Now, suppose instead of pinching down the flow, reducing the flow from the well, when you had such bottom hole choke in the well, suppose you had opened up the top of the well to permit more flow? What would have happened? A You would get the flow permitted by this bottom hole choke.

Q Would that flow actually increase? A Not beyond the point permitted by the bottom hole choke.

Q Do you know whether this problem and experience has been only limited to the experience of your company, or is it more widespread than that? A It has been common to the industry, wherever pressures have been high enough to cause that condition to develop.

Q You spoke a while ago of the use of heaters, I believe, or the placing of heat at the point where the freezing occurred. What objections, if any, were there to that practice? A In my opinion, there are several objections, Mr. Browning.

In the first place, the device in any event requires constant attention. As a matter of fact, in day-to-
22 day operation, its operation requires gas for fuel, which might otherwise be used for other purposes. It has been my opinion always that the process itself includes or involves some hazards of operation that are rather difficult to guard against.

Q Are you familiar with the device illustrated in patent application of Otis and Luccous, serial number 473,838 involved in this case? A Yes, sir; that is the one we refer to as the bottom hole regulator.

Q Can you tell me which would be more expensive to install for a company for the purpose of reducing bottom hole pressure to such a point you could use them, the heaters that you referred to or this bottom hole regulator system shown in this patent application? A Well, of course, you would not install a heater for the purpose of reducing that pressure. You would install a heater to try to inhibit freezing that might result in the reduced pressure at the surface.

But on the basis of comparing the relative cost of the heater installation as against the bottom hole regulator installation, I am quite sure that the regulator installation would be cheaper in any instance I can conceive.

Q Will you tell us the comparative cost of operation of a heater installed under such circumstances and
23 a regulator installed or in accordance with this patent application? A I would not be able to do that substantially, Mr. Browning, but you will recall a moment ago I cited what I considered to be a fact, that the heater requires more or less constant attention and that would involve day-to-day operating expense.

Q The salary of men, let us say? A Yes, and perhaps transportation for him, but in any event, the regulator in place would not require that day-to-day attention.

Q And does the regulator involve any operating cost comparable to the cost of fuel as burned in the heater that you speak of? A No, sir, it would not.

Q Is that amount of gas substantial in quantity for the usual installation? A Yes, it would be measurable and substantial; yes, sir.

Q Now, I call your attention to the large print of the Knowlton device patent, number 1,905,592, which is before you, and ask you if you are familiar with this patent? A Yes, I believe I am.

Q Will you kindly explain the manner in which the structure of this patent was intended to operate? A It was intended to operate as a restriction below
24 the surface of the ground within the well bore, and it was also intended that that restriction might be varied in size by means of manipulation through the string of tubing from the surface. In other words, this bottom hole restriction is subject to variation by manual control through the variation of the tubing string itself.

MR. BROWNING: May the witness step down and point to the drawing, Your Honor?

THE COURT: Yes.

BY MR. BROWNING:

Q Will you point out the place where this restriction shown in the well was located on that drawing? A It is located in the lower portion in the vicinity of the cone-shaped cross-section.

Q That part being numbered 12? A Yes, sir.

Q How far would that be in, let us say, minimum depth at which such device would be installed for a useful purpose? A If it were installed for the primary purpose, to take advantage of the earth heat by eliminating subsequent freezing in the gas stream, it would have to be 3,000 feet or 3500 feet or more below the surface.

Q Now, let us assume that it would be possible to adjust that orifice that you have indicated manually from

the surface of the ground to a desired opening to
25 permit a desired flow. Could you by the use of a valve at the surface of the well, such as that indicated by the number 34, vary that flow without involving the danger of freezing at the surface? A I think it could not, Mr. Browning. If anyone set that opening in the device worked out by Mr. Knowlton, you would have the equivalent of the bottom hole choke, a constant restriction, subject to variation caused by expansion or friction in the string, due to the action of temperature.

Q Would the effect of the control valve, such as valve 34 and located at that point, be any different from a mere shut-off valve, that is, one that can be open and shut to permit full flow or no flow? A In my opinion that would be the practical effect of this installation.

Q And the only way you could vary the flow, if I understand you correctly, would be by adjusting the bottom hole orifice? A I think that is right.

Q Resume your seat, please. Take the stand.

In regard to this Knowlton and Crites structure, do you know of any instance in which that structure was actually used in a well, within your knowledge? A No, sir, I don't.

Q You have never heard of it being successfully
26 used commercially? A No, sir, I haven't.

Q Now, with regard to this Otis bottom hole pressure regulator that you have referred to, do you have any knowledge of the actual working of that regulator in that field? A Yes, sir, I do.

Q Do you know the results of that working? A Yes, sir.

Q What was the result? A Well, within our own operation, we have utilized this device on a number of occasions and in a number of wells, and we have observed the results of these operations carefully over a period of time, and it is our observation that the device is able to maintain a reasonably constant pressure differential within the well stream, and that we made additional regulation at the surface so as to get variation in flow from the well.

Q Your company has had that experience or is that the experience of somebody else? A We have had that experience directly, and in addition we have observed experience on the part of others.

Q Do you have any knowledge of events in connection with the first trials of Otis in connection with the bottom hole regulators of this type? A Well, I do recall that one of the first trials, if not the first, was conducted in a
well owned by my company.

27 Q You mean, did Mr. Otis or someone else? A
Mr. Otis made an arrangement with us to install a bottom hole regulator in a well owned and operated by us for the purpose of running tests and making particular determinations with reference to its operation.

Q Is that customary with your company, to permit your wells to be used by persons trying out new devices? A No, sir, I would not say it is customary. In this case we were willing to do so because of the fact that we had theretofore utilized a number of bottom hole chokes, and we could see the advantages in this bottom hole regulator if Mr. Otis or anybody else was able to develop it. So that we were quite willing to permit this trial run to be made in one of our wells.

Q Do you feel that there were any hazards in connection with permitting such experimentation? A Well, there are always hazards in connection with the operation of high pressure wells, but we did consider that there were no undue hazards in this connection, otherwise we would not have felt we could permit it.

Q Why did you feel there were no undue hazards in this case? A Because the mechanical process is such that this bottom hole regulator, trying it out, is essentially the same as the process of the bottom hole
28 choke, and we felt that the hazard was a calculated
one that we had chosen to encounter before and

felt that we were not taking an undue liberty in this case.

Q And your feeling that you may have need for such tools, led you to take that calculated risk? A That is right; exactly.

Q Can you give us some idea of the depth to which gas wells are more or less customarily drilled as of today in the Texas and Gulf Coast areas? A As a general proposition now, today's well drilled to a depth of 11,000 feet or greater is not uncommon.

Q In other words, a depth of a little over two miles? A Oh, yes, sir. I might say this is within my own direct experience. We have drilled a few wells of that depth. We do have a lot of wells of depths around 9,000 feet.

Q And can you tell us what the range of high pressures in producing from such wells might be? A There again as a matter of direct experience, a pressure of three or four thousand pounds on the wellhead is rather common. It is general knowledge in the industry that pressures have been encountered in wells drilled by others much higher than that.

Q Of the order of what? A Up to 8,000 pounds.

29 Q Can you tell us—you referred a while ago to taking advantage of the natural heat in the earth to avoid freezing by expanding the gas down in the well. Can you give us an idea of the temperatures that are created by this natural heat in the earth at depths varying from 3,000 down to ten or eleven thousand feet? A Well, the highest temperature with which we have been confronted in a producing field where we have actual operations was 254 degrees Fahrenheit. I do know, of course, that there are higher temperatures. Generally speaking, we have to consider the line relative from the surface to the bottom hole, with an increase in temperatures as you go deeper.

Q Now, in the producing of an average good gas well, what would you say was a good economical rate of flow from an average good gas well of the high pressure type in which it would be desirable to use the Otis bottom hole regulator, as of today? A If you don't mind, Mr. Browning, I would rather not complicate it by having that word economical in there.

Q Let us say, good practice. A Yes, sir. I would say that good practice on a broad average basis would be to limit the wells to something on the order of three or four
million feet a day. I don't mean to say that you
30 take that much gas each day, day in and day out.

Q But that would be average is that it? A I think that might be a good average.

Q Are there times it might exceed that? A That is right.

Q In order to get some idea of how much gas is involved in that for domestic uses, how large a population would you say that amount of gas would serve in the winter time in an area in the latitude and climate of Dallas, Texas? A The peak 24-hour requirement, or the highest 24-hour requirement on an extremely cold day in residences will average about a thousand cubic feet, and the average residence in our section of the country consists of four or five people. That would mean then that you would take about three million a day, and you would take about in that case to supply 3,000 residences, on the order of twelve, thirteen, or fourteen thousand people.

Q From one well? A Yes, sir.

Q Producing through one of these, one or more of the bottom hole regulators in the one well, all of the gas would go through each regulator? A Yes, sir.

Q Can you tell us whether in the production of gas,
the gas is produced from the formation as a clean,
31 dry gas or, if not, what its condition is? A There
are wide variations, Mr. Browning, in the quality
and the character of the gas, depending upon where it is found. But, I would say, invariably there is moisture content, and by that I mean, water vapor there in the vapor form or liquid. Frequently, that water will have

salt content and will be what we call salt water. Very frequently there are so-called heavier hydrocarbons there in liquid form, or subject to liquefaction, and then in other cases there will be entrained solid particles, such as portions of the formation sand itself, if it happend to be unconsolidated enough to cause particles.

Q Can you tell us whether the entrainment of these other substances, the liquids and the solids, such as that, would create any problems in connection with the regulation of flow? A Well, yes, it created these different problems.

Q What problem was created in the case of sands, as well as liquids? A We have the problem of cutting action on various fittings, particularly where such must be used for purposes of pressure reduction, and the water vapor itself lends itself to the freezing condition to which I have already made reference.

And the presence of liquid will in some cases lead
32 to fluctuating rates of production at the wellhead.

Q I show you a large print of the drawing of the Bruce patent, 1,199,152, cited in the answer in this case, and ask you if you are familiar with that patent? A I have read it carefully, Mr. Browning, and I think I might say I am familiar with it.

Q Can you tell us what pressure would exist in the valve shown in this patent as used, as illustrated in this patent? What pressure would exist outside of the manifold or, in other words, on one side of this valve? A Well, all the pressures involved in the operation of that valve would be in the neighborhood of atmospheric pressure, plus or minus a few ounces.

Q In other words, do I understand you correctly, that the total differential across this valve that is illustrated here would be the maximum of a few ounces? A That is my impression on the device; yes.

Q What would be the maximum pressure with which that device would have to deal, in your opinion? A I think it would be in the neighborhood of atmospheric pressure.

BY THE COURT:

Q Of what? A Of atmospheric pressure.

BY MR. BROWNING:

33 Q And that is what, in absolute pressure? A
It depends upon where it is; in the neighborhood of
15 pounds per square inch, absolute.

BY THE COURT:

Q You say that is atmospheric pressure? A Yes, sir.

BY MR. BROWNING:

Q Well, now, are you familiar, generally speaking, with the characteristics of internal combustion engines, in a general way with their operations? A I think I might say that; yes, sir.

Q Do you know whether any engine that has been using such valve as this, whether there would be any pressure differential between the inside and the outside of an intake manifold? A I think that would be; yes, sir.

Q Now, in your reading, as you have stated, of Bruce patent 1,199,152, and of the Knowlton patent, 1,905,592, have you found any combination of surface controlled valve with regulator down in the well that would permit varying rates of flow without substantial change in the pressure reduction across the valve? A It doesn't suggest it to me except, of course, I know of the Otis bottom hole regulator which does that. I am quite certain, how-
ever, I considered this to be different. I knew
34 of the Otis bottom hole regulator, and that would
not have suggested a thing to me.

Q Are you familiar with the Otis patent, 1,920,103, concerning which I questioned you a few moments ago? A Yes, sir, I am.

Q Have you read that patent carefully? A Yes, sir, I have.

Q Have you found in that patent any such valve or regulator which would maintain a substantially constant pressure reduction for varying rates of flow? A No, sir.

Q Did you know Mr. Donald Knowlton? A Yes, sir, I did.

Q Do you know his standing and reputation in his profession? A I knew that he had a very high standing in the profession, Mr. Browning. He was an able engineer and was so recognized.

THE COURT: How much longer are you going to continue, Mr. Browning?

MR. BROWNING: I am about finished, Your Honor. I just have a few more questions and I will be finished with the witness.

THE COURT: Very well.

BY MR. BROWNING:

35 Q Do you know Mr. E. O. Bennett of Houston, Texas? A Yes, sir, I do.

Q Do you know anything about his reputation or standing in his profession? A Yes, sir, I do.

THE COURT: What is his profession?

BY MR. BROWNING:

Q Do you know what his profession is? A He is a petroleum engineer and consultant and has been so for a number of years. I think there is no question whatsoever about it that he is preeminent in that profession, one of the outstanding engineers of the profession.

Q Do you know Mr. William F. Knode of Fort Worth, Texas? A Yes, sir, I do.

Q Do you know his profession? A He is also a consulting petroleum engineer.

Q Do you know anything about his standing or reputation in his profession? A Yes, sir, I do.

Q What is that standing and reputation? A I think he has a fine reputation and standing, Mr. Browinng, and I think that will be generally recognized.

MR. BROWNING: That is all.

## 36 *Cross Examination*

BY MR. REYNOLDS:

Q Now, Mr. Potter, unless you use a valve at the top of the pipe to vary the flow of the fluid, a fixed bottom hole choke would be just as good as a variable one, wouldn't it? A That is correct, unless you were confronted with a varying line pressure, which would have about the same effect as variation in the valve at the surface.

Q So would you say that the advantage that this Otis automatic choke has resides entirely in its combination with the adjustable valve at the top of the pipe? A No, I don't think that is so. I do believe that is an advantage because by using the valve at the surface, you can vary the flow from the well and still have the same differential of pressure substantially across the subsurface valve.

Q Suppose you don't have a valve at the surface, what advantage would that have over the fixed bottom hole choke? A If the well were feeding into a gas transmission system that was subjected to varying line pressures, due to fluctuating demands on the other end, you would still have across the bottom hole regulator a substantially constant pressure, and you would have a varying rate of delivery from the well, notwithstanding
37 under those circumstances you would not use a
surface valve.

Q Well, then its advantage lies only in this combination with some sort of varying pressure at the top of the pipe? A As far as I have been concerned, my experience with it, its main advantage is the fact that it permits variation in rate of flow from a well with substantially constant pressure differential in the well bore at the point of the tool.

Q Your answer to that question would be, yes, then, wouldn't it? A Yes, sir, I think so.

Q Now, you have never actually seen the Knowlton device in operation, have you? A No, sir, I haven't.

Q And you don't know of your own knowledge of any attempt to use it at all, do you? A No, sir, I don't.

Q So that the conditions that you gave of its operations are just theoretical consideration? A Based upon consideration of the information in what I understand is the patent application itself; yes.

Q Do you see any theoretical reason why it could not
work as it is supposed to? A I can say, of course,
38 that for any one setting that device at the bottom,
you have got a constant opening and a single rate
of flow, except in so far as the size of that opening might be affected by the variations in the length of that tubing string, such as variations caused by changes in temperature.

Q Well, you would move the valve to compensate for those variations, couldn't you? A As a practical matter, I doubt it.

Q I mean, theoretically it is possible? A Yes, sir.

Q So that in theory it would be possible to obtain substantially the same result with this normal valve as here, one with skilled manual regulation? A Well, as a practical matter, you could not have the skill.

Q But, I mean, assuming that you had perfect skill, it could be done? A If you had perfect skill and could adjust perfectly, that is true, except that I don't see how you could fully compensate for changes in the length of that tubing string, due to temperature changes you would certainly encounter.

Q Well, why not? If the tubing got longer, you could
lift the valve? A Which would cause, in turn, an-
39 other temperature change and another variation in
the length, and you are up against an endless
proposition, as I see it.

Q It is your testimony, isn't it, that you think from practical difficulty that would render its operation unsatisfactory? Isn't that about it? A I think that is true.

Q Well, do you go any further than that? You would not say it is theoretically inoperative, would you? A Theoretically it is inoperative as a variable device, as I see it.

Q What theoretical reason is there why it could not be varied as used? A The theoretical reason is that it would be impossible to contend at the surface, throughout the tubing string, with variations in temperature that you would encounter when you induced changes in rates of flow.

Q Well, suppose you used pipe that didn't expand for changes in temperature? A I don't believe that there is any.

Q Don't you think by using a metal that has a zero coefficient of expansion to temperature would do it? A No, I don't believe so. I haven't had any experience with this as far as pipe is concerned.

Q You know the expansion of different material varies?
A That is right.

Q And some expand more than others? A Yes, sir.

Q If you used the lower coefficient of expansion, don't you think it would work? A It might have a better chance to work if you had a low coefficient of expansion.

Q Knowlton stated he varied the flow by variation at the bottom? A That is right.

THE COURT: How much longer will you be?

MR. REYNOLDS: Two more questions, Your Honor.

BY MR. REYNOLDS:

Q Referring to the Bruce patent, it is a fact, isn't it, that he shows that valve can be used in other places than in the specific location where he uses it? A I think that is true.

Q Is there any reason why it could not be built to operate under high pressures? A It could be, yes. It would, of course, require a great many structural changes.

Q Just as a matter of proportion and strength of parts? A I think the fundamental design would have to be changed.

41 Q Why is that? A If it were to be used, for instance, in a high pressure gas well, it would not be directly adaptable, as I see it.

Q Why not? A Well, the most important thing I am trying to point out now is the fact that its structure would not permit that sort of purpose.

Q I don't understand that. Could you make that clearer? A I think it seems clear to me that the Bruce patent is not constructed to contend with extremely large pressures. It seems clear to me also it is not constructed to contend with the cutting action of various materials.

If you consider those two, in conjunction with the extremely high temperatures, I doubt very seriously it would be adaptable.

Q Do you think a skilled mechanic would have any difficulty in revising it to operate under such pressures? A I think so. As a matter of fact, I believe it would be a true statement to say there is a great deal of difficulty involved in arriving at the proper design on the Otis bottom hole regulator. I think any mechanic, however skilled, would have some considerable difficulty in adapting it.

42 Q Why will the Otis device work under high pressure and the Bruce would not? A Well, for one thing it is constructed to eliminate as nearly as possible the factor of vibration. It is constructed to withstand the high pressures of wells.

What may be more important, it is constructed so that its spring movement is quite limited, whereas in this Bruce valve that is not apparently true.

MR. REYNOLDS: That is all.

MR. BROWNING: I have no further questions, Your Honor.

THE COURT: May this witness be excused, then?

MR. REYNOLDS: Yes, he may.

* * * *

44 MR. BROWNING: If the Court please, in the interest of more orderly procedure, I would like to offer in evidence at this time as Plaintiff's Exhibit No. 1, a certified copy of the file wrapper and contents of the patent application of Herbert C. Otis and John C. Luccous, filed January 28, 1943, serial number 437,838.

MR. REYNOLDS: No objection, it being the application involved in this action.

THE COURT: Very well.

(Thereupon the document was received in evidence and marked Plaintiff's Exhibit No. 1.)

MR. BROWNING: If the Court please, I would like to offer in evidence as Plaintiff's Exhibit No. 2 a folder containing several printed copies of the patent to A. S. Bruce, number 1,199,152, dated September 26, 1916, and a copy of the patent to Donald R. Knowlton—

THE COURT (interposing): Well, I think they are all contained in this folder that Mr. Reynolds has furnished. I don't think that there is any occasion to have them.

MR. BROWNING: You don't think it is necessary to offer them in evidence?

THE COURT: Well, you might look at this and see if they are in there.

* * * *

45 *Herbert C. Otis*

* * * *

*Direct Examination*

BY MR. BROWNING:

Q You are Herbert C. Otis, a resident of Dallas, Texas, and the plaintiff involved in this cause? A Yes, sir.

Q You graduated from the University of Michigan in February, 1917, and shortly thereafter entered the United States Army. Upon being discharged from the Army at the end of World War I, you were employed in February, 1919, by the Kentucky Oil & Gas Company near Bowling Green, Kentucky, and were in charge of drilling operations and of installation and operation of pumping units for that company. About one year later, about January 1, 1920, you were employed by the Southwestern Gas & Electric Company and Bethany Oil & Gas Company at Shreveport, Louisiana, and shortly thereafter you were put in charge of drilling, producing and transporting operations for the Bethany Oil & Gas Company and of the distribution in several towns for Southwestern Gas & Electric Company.

46 Is that correct?

A That is all correct.

Q During the time you were employed by Southwestern Gas & Electric Company and Bethany Oil & Gas Company, you were appointed by the Natural Gas Association to a committee to study the control of gas wells by means of surface chokes, and in this work you had additional opportunity to observe the operation of natural gas wells under many varying conditions when controlled by surface chokes?

Is that correct?

A That is correct.

Q While you were employed by the Bethany Oil & Gas Company and its successor, the Arkansas Natural Gas Company, you developed a means for inserting tubing, or siphons, into gas wells without opening the well to the atmosphere?

Is that correct?

A Yes, sir.

Q And you formed your own company to operate under this method, and the demand for such service was so great that on January 1, 1930, you resigned from your position with the Arkansas Natural Gas Company to devote your full time to the operation of your own company, Southern States Company, a Louisiana corporation? A That is correct.

Q And that company was engaged in installing 47 siphons under pressure in producing gas fields throughout the midcontinent area? A That is correct.

Q What was your occupation since January 1, 1930, when you resigned from the Arkansas Natural Gas Company? A My principal occupation has been the designing and the building of sub-surface control equipment and the operating of the service company and installing subsurface control equipment in high pressure wells.

Q Is that business that you have just mentioned the one in which you are still engaged? A Yes, sir.

Q And is that business conducted by you as an individual or through a corporation? A Through a corporation.

Q And what is the corporate name under which you operate? A We operate through two corporations, the Otis Engineering Company, being a designing and manufacturing corporation, and Otis Pressure Control, being a sales and service organization.

Q Mr. Otis, in connection with your testimony and the testimony of others, there have been and will probably be a couple of terms used which I would like to have you to define, if you will.

48 The first of these being a term expressed as "pressure differentials."

A In oil field parlance, we refer to "pressure differential" in one sense as a difference in pressure. If we assume a piston with a thousand pounds on one side and 500 on the other, we say that the "pressure differential" is 500 pounds across that piston.

And the same way, if we have an orifice in a gas well, and on the inlet side of the orifice have a pressure of, say, 1500 pounds, and on the outlet side of the orifice have a pressure of 500 pounds, then the "pressure differential" across the orifice is a thousand pounds.

Q Now, Mr. Otis, in referring to the orifices regulators and so on, you might use the expression "upstream" from the orifice and downstream from the orifice, or "upstream" from the regulator and downstream from the regulator, and what would you be referring to in the case of an orifice or regulator located in the well tubing? A As used in these instances for this case, the term "upstream" is perhaps a little misleading in that "upstream" means inlet side.

BY THE COURT:

Q Means what? A The inlet side. And "downstream" means the discharge side.

49 The well regulator located in the well, down in the well, is set up on the "upstream" side of the surface choke because it is on the inlet side of the surface choke as it is way down in the well.

BY MR. BROWNING:

Q And conversely, the surface choke would be set up "downstream" from the regulator? A That is correct.

Q Now, will you tell us what is the meaning, in ordinary parlance in the oil and gas industry with reference to "fluid" and "well fluids", or "fluids in the well"? A By the term "fluid in a well", we mean a liquid in the well as compared to or opposed to dry gas. If it is gas we are dealing with, that gas is referred to as gas or as dry gas, not as "fluid", but if there is water or you should have mud in the well, it is referred to as "fluid."

That is not, of course, a correct terminology, but it is the only terminology I have ever heard in the fields.

Q In the course of your work in your present line of endeavor, have you made any inventions other than the one here in issue, relating to that line of endeavor and had issued and secured patents? A Yes, sir.

Q How many such patents would you say have 50 been issued to you approximately? A In the neighborhood of 40.

Q Have you in connection with your work in this industry kept close touch on patents issued to others in the same line of endeavor? A Yes, sir.

Q And in the course of applying for and prosecuting applications for your own patents and considering your own patent features, have you had occasion to consider the meanings and the terms of the claims of the patents? A Yes, sir.

Q I call your attention to patent number 1,920,103 cited in the answer in this connection and ask you if you can identify that patent. A Yes, sir, I can readily identify it.

Q What is the structure to which this patent relates? A It is what we have always called a removable bottom hole choke, or a fixed bottom hole choke, that is removable.

Q What does that consist of in ordinary language? A It consists of a carrier or mandrel that includes slips for setting it, and a means to prevent the flow of gas around it, and a restriction to control the effective orifice through it.

Q Is that passageway sometimes closed during the time that the well is in producing condition or is it always open? A It is sometimes closed.

51 Q How is it closed? A It is closed as shown in that drawing, for instance, by a ball in there, by means of what we call a blank bean, by a closure across the bottom. That is employed at times when it is desired to completely block the string of tubing.

Q Would that ball that you mentioned be the element shown in Figure 4 and indicated by numeral 55? A What was that, sir?

Q Will you point out the ball, you just referred to?

THE COURT: I can see it from here, Mr. Browning.

MR. BROWNING: Let the record show the witness indicated ball 55 in Figure 4.

BY MR. BROWNING:

Q Are you one of the inventors named in this patent? A Yes, sir.

Q What was the purpose of the structure in this patent? A The first purpose was to block the string of tubing that had to be run under pressure in a completed high pressure well, and subsequently unblocking that string of tubing after having moved the string to the desired point.

Q After unblocking it, what would you do with the well? A The well would go back onto production.

Q How would it go back on production? Would
52 this patented structure have anything to do with
it? A No. We removed the structure and the control of the well would be done at the surface chokes.

Q Was this structure ever used in the well while it was being produced? A Yes, sir.

Q For what purpose? A In controlling the rate of flow at a point sufficiently deep in the earth to prevent any general freezing of fluids and gases taking place as they pass through it.

Q And when you say you use such a device in the well for controlling the rate of flow, is there any other means in connection with the well for controlling the rate of flow? A No; that depends upon only this—

Q (Interposing) Well, when using this device in the well for controlling the rate of flow, can you use it to vary the rate of flow without removing it from the well? A You cannot.

Q Could a well so equipped be produced with the desired or substantially desired pressure reduction at the bottom of the hole at more than one rate of flow? A It cannot.

Q What would be the result of an attempt to draw from the well having a fixed bottom hole choke, such as
described in this patent, a quantity of fluid more
53 than that for which the bottom hole choke was de-
signed? A It just cannot be done. It is limited to the quantity that can then be produced from the well, and by the capacity of the bottom hole choke. Opening

the surface choke further would not increase this capacity.

Q What would be the result of an attempt to draw less fluid that that for which the choke was designed? A The surface pressures will climb, until they are high enough to cause freezing, the same as if no bottom hole choke were employed.

Q In using the term bottom hole choke, does that term mean that the choke is located exactly at the bottom of the well? A No, it means this in our parlance, it is located sufficiently deep in the well to preclude freezing.

BY THE COURT:

Q To what? A To preclude freezing. When the pressure is dropped across the choke, the temperature both of the fluids entering that choke and of the earth around the choke must be high enough to offset the loss of temperature as the result of the expansion, so that no freezing can occur.

Would you like to go into instances of that or would you not?

MR. BROWNING: I think it will be unnecessary at this time, unless His Honor would like it. 54

THE COURT: No, I think that is sufficient.

BY MR. BROWNING:

Q In your work of production from formations in which pressures of the order of several thousand pounds per square inch exist, have any problems come to your attention peculiar to such operations that were not involved in the operation of lower pressure wells, from which the production products flow at lower pressure or have to be pumped? A Yes, sir.

Q What is the main difference in the problems involved between such high pressure and low pressure wells? A The principal difference would be the tendency of the well to freeze up.

Q At what point? A At a point immediately adjacent to, or even to some extent, downstream of the point of pressure reduction.

Q Do you mean then that you would have to reduce the pressure of the high pressure well before you can make use of the products? A That is correct.

Q Can you state when the problem dealing with freezing in connection with making such pressure reduction at or adjacent to the wellhead first came to your attention?
A It first came to my attention about 1921 or
55 1922, when I was put in charge of the operation of
high pressure wells for the Bethany Oil & Gas Company.

Q Do you know whether or not, to your knowledge, whether such difficulties were experienced by many operators or just a few? A I know it was experienced by many operators.

Q Can you tell us the most direct method within your knowledge that has been employed in dealing with and preventing freezing where the expansion of gas is accomplished at or near the well head? A The most—at that time, the customary method of dealing with this problem, which I presume is what you mean by most direct method, is the heating of the gas or the fluid immediately prior to its going through the choke, and if necessary reheating as soon as it comes out of the choke.

Q Did you prior to conception of the invention for which patent application 473,838 relates receive requests or expressions of the desire on the part of customers for a device to be employed to provide a means of solving this freezing problem? A I did.

Q Can you name any customer or customers from whom such request came, and if possible the person who
made it to you? A Yes, sir. Mr. Nowery in
56 charge of drilling and production for what was at
that time the Palmer Corporation, since then and now the United Gas Company, who called me one morning and told me that just prior to that time they had had a heater blow up and kill a man, and he asked me if there wasn't perhaps, if there wasn't some means we

could figure out or method we could figure out for producing of these high pressure wells in which it would not be necessary to employ a heater, and still not have freezing at the surface.

Q What was your reply to that request? A My reply was to the effect that I thought I could do it.

Q And did you do it? A And we did it; yes.

Q How did you do it? A We did it by the installation of the removable bottom hole choke, such as shown in the exhibit, at a depth, as I recall it, of about 5,000 feet.

Q You refer to the bottom hole choke. Is that the structure shown in patent 1,920,103? A That is correct.

Q About when was that, Mr. Otis? A That must have been in the neighborhood of 1930. I can't be sure on the date but that should be about right.

Q Now, with that installation in the well, was there anything further to be desired by way of control
57 of this freezing problem? A Yes, sir.

Q And what was it? A That installation was such as to permit no variation of the rate of withdrawal from the well, and the well would produce only at the one rate or at the capacity of the bottom hole choke.

Q Was it desirable to produce at varying rates from the well? A It was highly desirable to be able to do that.

Q Now, with reference to your patent application, serial number 473,838, have you placed on the market the device constructed in accordance with that patent application? A Yes, sir.

Q Do you have one of those devices? A Yes, sir.

Q Will you produce it, please?

Is this device that you have just handed me exactly as you put it on the market, Mr. Otis?

A Yes, sir.

Q Let me ask if this is the spring—do I understand that there is no spring in this device? A The spring in there is a light one.

BY THE COURT:

58 Q What is that? A The spring in this particular model is pretty light. The spring that is employed in one that is actually to be used is of necessity quite heavy, and we cannot assemble or disassemble this unit with the heavy spring in it, but we can with the light spring. That is, if we assemble or disassemble it by hand, as we would have to do here.

BY MR. BROWNING:

Q Do you have one of the springs, such as is used in your actual commercial product? A Yes, sir.

Q Will you produce that please?

The commercial model and the spring produced by the witness are offered in evidence as Plaintiff's Exhibits 2 and 3.

(Thereupon the objects were received in evidence and marked Plaintiff's Exhibits 2 and 3, respectively.)

MR. BROWNING: Do you want to see them, Your Honor?

THE COURT: No, I do not think so.

BY MR. BROWNING:

Q Do you have another of those commercial models which has been hollowed or cut away in such fashion it can be more readily seen as to what is inside of it, in other words? A Yes, sir.

59 Q Would you produce that, please?

Are the springs there in this model the springs such as you use in your commercial product?

A The lower spring is identical with that which we use in the product, but the upper spring, of course, is not.

Q How does that compare with the spring you use in your regular product? A I believe you have just been shown the spring which we actually use, and it obviously is many, many times stouter than the spring we have included here.

We have included this light spring to permit ready manipulation by hand. If the heavier spring would be included, we could not manipulate it by hand.

MR. BROWNING: The cut away commercial model produced by the witness is offered in evidence as Plaintiff's Exhibit 4.

(Thereupon the object was received in evidence and marked Plaintiff's Exhibit No. 4.)

BY MR. BROWNING:

Q Now, referring to the enlarged prints of the drawing of your patent application, which are hanging here in the courtroom, will you explain the structure and the operation of the invention therein shown?

Do you have a pointer that you can use?

A Yes, sir.

Q Will you step down and explain it to the Court?

A The first drawing shows the well casing and the
60 well tubing, and with the two control members generally employed in place.

The upper control member is the surface choke, and the lower control member is the pressure regulator. This pressure regulator, incidentally, is run into it and set, and if necessary subsequently pulled from the well, after the well is completed, and with the full pressure on the well during the operations of running and pulling. The operation is a relatively simple one, running in and pulling it.

Q Will you point to the pressure regulator that you just referred to? A Yes, sir; this portion right here or right here (indicating).

Q Point to the element as shown in the drawing. A Yes, sir.

Q Does that pressure regulator, does it correspond to the model that was just offered in evidence as Plaintiff's Exhibit 2? A Yes, sir.

Q Proceed with your explanation. A Our purpose in using this regulator in this manner is to use up or dissipate at this point, well below the surface of the earth, that extra part of the well pressure, the high well pressure, that is causing freezing at the surface, yet leaving

above the regulator sufficient pressure to permit
61 variation of the rate of withdrawal from the well at the surface choke.

We take a high pressure well and by means of this regulator in effect convert it, so far as service is concerned, to a low pressure well. That has at least two advantages, one of which is to reduce the very severe strain occasioned by the high pressure, in extreme cases pressures of in excess of 8,000 pounds per square inch, on the surface connections.

These pressures are dangerous, and the holding of these pressures is a very severe trial. If leakage once starts at such pressure, there has to be fast action or the well is turned loose.

And the other purpose of the invention is to so reduce the surface pressure that we can, by means of the surface choke, vary the rate of withdrawal from the well at the pressure we are handling, as the result of the reduction by the regulator, so as not to be a high pressure that would cause freezing, but at a reduced pressures similar to low pressure wells, so that no freezing results.

Q Will you refer to sheet 2 of the application drawing and tell us what you find there? A In Figure 2 at the top we have a locking and sealing mandrel assembly. That is the assembly which locks the tool in place, including the slips 39 and the packing elements 41.

62 The pressure regulator includes the housing and the valve member, in this instance the stationary valve member, and the movable valve sleeve surrounded by that packing at the upper end, and by the coiled expanding spring, tending to close the valve, to bring the valve members together.

Q And does that regulator, as you stated, create pressure reduction in the well so that you can operate the well at the well surface as though it were a low pressure well? A Yes, sir.

Q Now, I turn to sheet 3 and ask you to explain the difference between what is shown on sheet 3 and what is shown on sheet 2, that you have just explained. A There are two changes shown on this sheet. In this figure we have shown what was the stationary valve as a valve which can be moved downwardly away from the movable valve in the other figure, and in this figure—

Q (Interposing) In these figures? What figures are you referring to? A I refer to figures 7 and 8.

Occasionally it is necessary in the operation of high pressure wells to have to pump into the well in a hurry to kill it. It may be trouble with the surface connections or casing or packer failure, any one of several reasons
can necessitate the pumping of heavy fluids into the
63 well to kill that well.

This valve is designed so that if the pressure from above is greater than the pressure from below, it will move downwardly. The flow would then come down through the upper valve element out through the inlet ports and down to the bottom of the well.

Q The number of the designated valve element, which you say moves down under pressure from above, is what? A Number 65.

Q Now, is there any difference in the operation of this structure that you have just been explaining as compared with the structure shown on sheet 2, in so far as its use for reducing pressure in the well is concerned? A There is no difference.

Q Proceed. A Well, also in Figure 11, our valve member 65 is shown with the small port through it. It occasionally happens that a high pressure well is produced at quite a low rate, and I mean by a low rate a half million or a million feet a day, accompanied by a reasonable amount of fluid, perhaps 40 or 50 barrels of fluid a day, and that fluid may not all come to the surface. The velocity of the flowing gas is so low that slippage results, particles of fluid drop out and start back to the bottom. Or, if a
stream is carrying grains of sand, and that stream
64 if it is carrying sand, may not move at sufficiently
high velocity to continue carrying it.

If a well under high pressure is produced at a low velocity and sufficient fluid, water or oil, accompanies that gas, that fluid is apt to settle and accumulate on top of the regulator, and in time sends that pressure to—adds to the gas pressure acting downwardly on the valve, and causes the regulator to close and permits no more flow.

We have drilled this small port through the lower valve so that, should such a condition occur, the gas can continue in small quantities to come through the lower valve and to raise this accumulation of fluid on top of the regulator. This gas which comes through here has not been subjected to the pressure reduction that the gas which passes between the two valve members has been subjected.

Since it does not pass through this valve, it comes straight through the assembly and has more energy with which to life the accumulated fluid.

Q Now, the small port that you refer to appears as what numeral? A That is 70, reduced; however, at its lower end.

Q Is the operation of this latest structure that you have described in reducing pressures in the well comparable to the structures previously described? A Yes, sir.

Q Have you placed on the market these various
65 structures that you have described? A Yes, sir.

Q All of them? A Yes, sir.

Q Resume your seat, please.

In your exploitation of the invention, have you personally manufactured and installed devices, or through some other outlet or corporations? A It has been done through our own corporation and through other corporations as well.

Q Through your own corporations? What are the names of those? A Otis Engineering Company and Otis Pressure Control, Incorporated.

Q Who in your organizations has had most to do with the installation and work in the field in regard to the invention as illustrated in your patent application 473,838? A Mr. I. A. Miller.

Q How long has he been with your organization? A At least 19 years.

Q Who in your organization had the most experience with this invention in regard to calculation, strength of parts, and proportions, and so on? A Mr. Harry Schramm.

66 Q Were you present on May 24, 1949, at a well known as South Jennings Well, Unit No. 8, Jennings, Louisiana? A Yes, sir.

Q What was the occasion for your visit to that well? A To observe the installation of two of our regulators in a very high pressure well belonging to the Stanolind Oil & Gas Company.

Q Did you observe the installation of these two regulotors? A I observed the installation of only one.

Q Why was it you didn't observe the installation of both? A Because darkness intervened, and it was necessary for me to return to Dallas.

Q What was the condition of the well at the time you first observed it? A The well was being what they call cleaned, or the well was being flowed through a surface choke as much as they dared to flow without running the risk of damaging the well, and in hope this flow would carry out from the well all of the mud that was present in the well tubing and in the bottom of the well.

The gas that was flowing to the atmosphere along with the mud brought to the surface was being burned at some distance, perhaps 200 feet from the well, in what they call a flare, an upright length pipe, that is set on fire so 67 it would not accumulate and possibly be ignited with a resulting explosion.

Q Do you know the pressure that existed inside the wellhead at this time that you arrived there? A That pressure was approximately 6900 pounds while the well was being produced rather hard through the flare.

Q Was the well or was it not later shut in so that there was substantially no flow? A Yes, sir, it was.

Q And upon being shut in, do you know what the pressure at the wellhead was? A It rose to 7100 pounds.

Q While the well was shut in, did you or did you not observe the condition of the choke through which the well had been flowing? A I did.

Q What was its condition? A There was slight leakage through it. The shutoff wasn't complete.

Q How did you know that? A We knew that by the fact that frost and ice was accumulated around it, even at that very low rate of flow through it.

Q What was done, if anything, to prevent that freezing while the well was flowing to the flare? A Water was kept circulating or being pumped on the
68 surface connections.

Q Just ordinary water? A Water that had been warmed. Warm water was being pumped on the connections to keep them warm enough to preclude freezing.

Q Will you explain, as briefly as you can, just what the operation was of inserting the regulator into the well? A After it was assumed that the mud had been completely removed from the tubing by flowing the well through the surface choke at a high rate and discharging it through the flare, the well was closed in at the surface.

Then our men, one of our service crews, assembled this regulator, attached it to the running tools. There was a string of jars, and a sinker, and the running tool, in turn, was attached to a long steel line, somewhat like piano wire, this line having a diameter of 0.082 inches, having considerable tensile strength. This line was then passed to the power unit through the stuffing box, on the upper end of what is called a lubricator section of pipe, about 20 feet long, and this section being closed at the top with the stuffing box which permitted the passage of the wire through it. Then the tools, the running tools and the regulator, are drawn into this lubricator and the lubricator is bolted on the flange on the top of the well, above the tubing gate valve.

After that is done, the gate valve is opened to
69 permit the passage of gas under pressure into the
lubricator so that the pressure within the lubricator is the same as that within the tubing. If we had 7100 pounds on the tubing, we then had 7100 pounds within the lubricator, and the gate valve would be opened so as to furnish no obstruction to the lowering of our tools, and the tools were lowered to a depth of, as I recall it, 9900 feet, where there was a J-nipple that was prepared for it. The regulator was set at that point, and the tools disconnected from it by manipulation of the jars, and the tools pulled to the surface, and into the lubricator and the valve beneath the lubricator closed, and the pressure within the lubricator was then bled off.

The next step would be to flow the well again to permit the flow to lower the pressure on the top of the regulator so it will correspond with the regulator and then setting the regulator will go into operation.

The regulator would not open to admit more gas into the tubing above it until after the pressure above it had been reduced to a predetermined extent. After the pressure above the regulator has been lowered to that extent, the regulator would open to maintain a constant pressure differential across it.

Q Could you vary the flow from the well thereafter
without disturbing that pressure, reduced pressure
70 above the regulator that you just mentioned? A
We could then vary the flow from the well without appreciably any pressure differential change across the regulator.

Q That is the difference between the pressure above and below the regulator? A That is right.

Q Was there any pictorial record made in your presence at the well showing the proceedings that you just described? A Yes, sir.

Q What was the nature of that record? A An 8 millimeter movie was made of some of the operations.

Q Have you witnessed a projection of that picture? A Yes, sir.

Q Do those pictures truly represent the operation and events which took place at the well while you were present? A Yes, sir.

MR. BROWNING: Your Honor, we have a very short 8 millimeter movie. We are not offering it for the purpose of proving the things that took place in this particular well, but in order to give you a background of the conditions under which this regulator is used, and so that the Court will better be able to compare those conditions with the conditions of use of the Bruce patent valve, which is one of the patents cited against this application.

71 I would like to know if the Court will permit us to project these pictures at this time?

THE COURT: Very well.

MR. BROWNING: Your Honor, the only electrical outlet is behind you. Could we put the projector beside the witness and run the cord from there?

THE COURT: Yes.

Whenever you are ready, I will have the lights put out.

(Thereupon a moving picture was exhibited to the Court during which the following occurred:)

BY MR. BROWNING:

Q Mr. Otis, I have stopped the projection of the picture, and I wish you would explain what the projected view illustrates. A This view is merely a portion of the derrick and of the drilling rig. The derrick used is not the customary derrick. It is a jackknife type derrick which pivots on two points. In this case the derrick has been tipped over to be removed from the location.

Q Will you step up to the screen and show the location of the derrick? A This is the lower end and it continues to my left from these draw works.

72 Q Where is the draw works located? A In the extreme right corner.

Q Of what? A The derrick floor or platform.

Q How high is that from the ground? A In that instance it was 15 feet from the ground.

Q I have stopped the projector again, and I wish you would tell us what that view shows. A That view shows the pressure gauge at the well surface.

Q Can you tell the pressure indicated on the gauge at that point? A The pressure is approximately 6900 pounds. The 7,000 pound mark can be seen just slightly to the right of this needle, indicating a reading of possibly 6900 pounds.

Q What was being done at the time that reading was shown? A That reading was taken with the well flowing or producing into the flare.

Q I have stopped the projector again. What is shown in that view there? A There are shown two of our subsurface regulators, or those being discussed. In fact, all three are regulators ready for installation in the well.

Q I have stopped the projector again. Will you tell us if you recognize anyone shown in that view there?
73 A I am afraid that is a picture of me with one of the tools ready for installation.

Q Where was this view taken that is shown in the projector where I have stopped it? A That picture is taken on the floor of the platform, on the floor of what was the derrick, at the elevation of the top of the well surface connections.

Q Can you tell us what is shown in the view where I have again stopped the projector? A That shows the regulator and the running tools pulled up in the lubricator prior to fastening the lubricator on the wellhead.

Q Will you point out the position of the regulator in that view? A That is shown right here.

Q Where is the lubricator that you refer to? A This is the flange at the base of the lubricator that couples the lubricator to the well connections.

Q Do the well connections appear in that view? A Yes, sir. This is the tubing gate valve.

Q And that gate valve does what? A That is the means to close off or shut the well tubing.

Q The upper end of the well tubing? A Yes.

74 Q Will you point out in that picture—first of all, tell us in this view where the projector is now stopped, what is being done? A The lubricator is being flanged to the tubing gate valve.

Q By flanged you mean bolted on? A Yes.

Q Will you point out the flanges there being bolted together? A Here and here (indicating). This flange is at the base of the lubricator. This flange is a part of the tubing gate valve, or built on to the tubing gate valve.

Q Can you tell us what that view shows where the projector is now stopped? A That view shows the pressure gauge reading, or indicating the pressure on the tubing after the flare has been closed in, or after the flow from the tubing has been stopped.

Q And that pressure is what? A 7100 pounds.

Q What is shown in this view where I have stopped the projector? A That view shows a restricted portion of the surface choke. It shows this bean as being covered with the frost resulting from the expansion of
75 the small amount of leakage that was occurring.

Q Will you point to that part that is covered by frost? A That white portion. That is normally black but it is white because it is covered with frost.

Q What was this man doing in the view where the projector is now stopped? A This man was opening the tubing gate valve to permit the pressure and the gas within the tubing to flow into the lubricator, or to place the lubricator and the tubing under the same pressure.

Q It seems to be very difficult for them to open that valve. Why is that? A Because of the high pressure. It is 7100 pounds.

Q Will you explain to us this view that is now being projected? A This view shows the reel and the steel line while the tools and the regulator are being lowered into the well.

This is the counter showing the depth of the regulator. It was 6100 feet at that point.

It is being lowered quite rapidly.

Now, it is 9965, and motion is stopped.

Q In this view that is now being shown on the screen, what is illustrated? A I would like to see that
76 clearer, but it shows the supports or the means of supporting the lubricator against horizontal motion.

Q What are the two vertical lines shown in the center of the picture? A This is the lubricator. These are the pieces of pipe used in raising the lubricator.

Q By the term lubricator, do you mean anything having to do with grease, oil, or anything like that? A No, that term does not have any connection. I don't know how it started, but it has been used ever since I have been in the field.

Q What is being done in this view that is being projected now? A The man after closing the tubing gate valve is draining the pressure within the lubricator so the lubricator can be taken from the well.

(Thereupon the projection of the moving picture was concluded.)

MR. BROWNING: Your Honor, was there any portion of that picture that you would like to have projected again?

THE COURT: No.

BY MR. BROWNING:

Q Mr. Otis, have you caused any stills to be made from the film that has just been shown? A Yes, sir.

77 Q Would you recognize those if you saw them? A Yes, sir.

Q I hand you a booklet and ask you if you can identify its contents? A Yes, sir.

This is a picture of the flare burning.

A picture of the gauge showing the pressure of 6900 pounds.

This is three regulators laying on the ground, one regulator ready for running.

The lubricator prepared and being pulled into the lubricator to be run into the well, and a picture of the flanges showing the connected lubricator to the tubing gate valve.

The pressure gauge showing 7100 pounds which existed on the well at the time the well was closed in, during the time they were running the regulator to the bottom.

This surface pictured shows the accumulation of frost from slight leakage occurring at that time.

This is the unit or the reel which carries the steel line by means of which the regulator is run into or pulled from the well, the meter on the reel showing the regulator at a depth of 9965 feet.

This is the flare with the flow cut off as was the case when running the regulator into the well. We have the very small flame resulting from the small leakage 78 through the surface choke, which choke had cut out during the few minutes or short time while blowing the well and cleaning the mud out.

The pressure gauge reading 6300 pounds was the pressure in one instance while the pressure above the regulator was being lowered.

THE COURT: Now, they are reproductions of the pictures when you stopped the projector and the witness testified?

MR. BROWNING: If Your Honor please, the projector wasn't always stopped at the exact point where these stills were taken, but they are taken from the film as indicated by this witness.

THE COURT: Very well.

MR. BROWNING: I offer in evidence the book of the still pictures which the witness has just testified about and ask it be marked as Plaintiff's Exhibit No. 5.

THE COURT: It will be admitted.

(Thereupon the booklet was received in evidence and marked Plaintiff's Exhibit No. 5.)

MR. BROWNING: Would you like to see these, Your Honor (handing to the Court)?

BY MR. BROWNING:

Q Now, Mr. Otis, the Knowlton patent, 1,905,592, shows on its face an assignment to the Phillips Petroleum Company of Bartlesville, Oklahoma, a corporation of Delaware.

Do you know whether that Phillips Petroleum
79 Company is or is not a regular customer for the
bottom hole regulator of your manufacture? A
I do.

Q Which is made in accordance with patent application serial number 473,838? A Yes, sir.

Q Is that company a regular customer or is it not? A It is a regular customer.

Q And, Mr. Otis, please refer to the Bruce patent, number 1,199,152, cited in the answer in this action.

Have you studied this patent?

A Yes, sir.

Q Can you state the purpose of the regulator shown in this patent as reflected by the patent? A The purpose of that regulator device very definitely is to regulate the rate of air intake or of flow by means of pressures already existing and existing independently of this tool, within and without the intake manifold.

THE COURT: Now, which patent is that?

MR. BROWNING: That is the Bruce patent, Your Honor, 1,199,152.

Do you have a copy of this patent?

A Yes, sir.

Q Will you refer to it, please? A Yes, sir.

80 Q I will ask you to refer to the first page of the
specifications of that patent and to read, if you
will, the second and third paragraphs. A (Reading) The object of my invention is to provide an automatic valve, of simple and cheap construction and of few parts, whereby the flow of fluids there through, especially those

of gaseous form, may be automatically regulated by the action of the varying pressures exerted by such fluids. Such valve may be used with advantage as in airtake for the inlet of the manifold of internal combustion engines, and is shown and described herein as so placed.

From the drawing and description it will be seen, that my said improved automatic regulating valve, may be used with advantage, to automatically regulate the flow of all fluids, by the varying pressure, whether the pressure upon the moving and actuating parts of the valve is varied by increase of pressure upon the inlet side, or diminution of pressure upon the outlet side, of such moving and actuating parts.

Q Is there anything in there to indicate that the Bruce valve had as its intention or purpose the creation or maintenance of any pressure differential? A No, sir.

Q What was its purpose? A Its purpose was
81 to regulate the rate of flow of air through its members in response to lowering of the pressure of the gasoline mixture within the manifold. It was simply a matter of regulating the flow, the rate of flow.

Q And the varying pressure differential within the manifold, would that or would not it have existed without this valve? A That pressure differential and the pressure variations would exist whether that valve was present or not.

Q Now, with respect to your subsurface regulator, does that subsurface regulator act to determine the amount of flow through it? A No, sir.

Q What does it regulate? A Our regulator regulates the pressure differential across its members, or the pressure differential across the assembly.

Q Would there be any pressure differential between the points above and below that where the regulator is set if the regulator were not set? A There would not be.

Q And with the regulator there these pressure differentials do exist? A Yes, sir.

Q And they are maintained? A Yes, sir.

82 Q Do you know the range of pressures with which the valve shown in this Bruce patent was intended to deal? A Approximately.

Q What was it? A From atmosphere to a few ounces less than atmosphere.

Q And atmosphere would be what? A Approximately 14½, possibly 15 pounds, depending upon your elevation.

Q What is the purpose of the spring in your regulator? A The purpose of the spring is to impress upon the movable valve member the energy necessary to cause the desired reduction in pressure—to cause and to maintain, I should say, the desired reduction in pressure.

Q And would that reduction in pressure that you mean to maintain be so that it would be substantially constant or would it vary? A To maintain it as a substantially constant figure.

Q Referring to Figure 2 of the patent drawing of your application, will you explain to us why the spring, that is number 28, is made to surround the sleeve 22? A Gases and the fluids flow past the two valve members.

THE COURT: While I am on that, what are you referring to, please?

MR. BROWNING: This is the spring 28 and the tube 22, which is inside of it.

83 THE COURT: Very well.

THE WITNESS: Virtually all natural gases carry with them some sand or some liquids, and the velocity of that gas as it leaves or passes through the two valve members is in the neighborhood of sonic, or even supersonic speed, and at these extremely high velocities, it is very obvious that at the orifice it would be very severe, and, in fact, pretty tremendous, just inconceivable velocity, and we have placed our flow member through the spring to keep the impact from the sand flowing through the valve, and the gases, off of that spring.

Without that, the spring would be very short lived in most wells, and a matter of four or five minutes use would take it out.

BY MR. BROWNING:

Q Have you made a study of the Bruce patent, and of the Knowlton, et al., patent, 1,905,592, cited in the answer, and are you fully familiar with the Otis patent, 1,920,103, cited in the answer? A Yes, sir.

Q And have you in any of those patents found a combination of surface control valve with an automatic pressure regulator for providing a substantially constant pressure reduction down in the well so that the well flow may be controlled as to volume at the surface without freezing? A I have not.

84 Q Have you found in any of these prior patents any showing of a pressure regulator which could without substantial change be employed in the well for the purpose of providing a substantially constant pressure reduction down in the well while the rate of flow of the well is being varied? A I have not found any such tool in these particular patents.

* * * *

Q Now, Mr. Otis, did your organization keep regular records showing the sales and installations of sub-surface regulators made in accordance with the invention and the application in this action? A Yes, sir.

Q Do you have such records? A Yes, sir.

Q Would you produce them, please? Are these actually and regularly kept records of your company on this matter? A Yes, sir.

Q And do each of the papers in the books that you have produced represent the sale or installation of one or more of these subsurface regulators? A Yes, sir.

85 Q Do you know from examination of those records what those records show with regard to the

number of different gas fields in which those sub-surface regulators have been installed? A I have had such a tabulation prepared.

Q Will you tell us what the result of those tabulations are from these records? A This tabulation shows that we know of 419 different gas fields and oil fields in which these regulators have been installed.

Q Does that necessarily represent all of them A It does not.

Q Why? A Because in some instances the tools have been sold direct to companies who have made their own installations, and our service crews were not involved in the operation. In quite some several instances, that is the case.

Q Do these reflect the gross dollar volume of your sales and installations of the sub-surface regulators? A They do.

Q Do you know what those records show as being the total dollar volume for the installation and sale of these regulators? Will you tell us that? A Yes, sir, in just a moment.

Our gross dollar revenue is $681,411.17.

86 BY THE COURT:

Q How much was that amount? A $681,411.17.

BY MR. BROWNING:

Q Are all the fields in which the regulator has been used located in the United States? A No, sir.

Q Now, Mr. Otis, did the first one of these regulators that you had made with the idea in mind of producing a substantial constant pressure reduction get down in the well, and did it work and actually become your commercial model without any more than just one test? A No, a very considerable amount of test and change of design was necessary before getting the tool we have today.

Q Was there any expense attached to that? A A very considerable expense.

Q Of the order of how much? A I will venture a guess at forty to fifty thousand dollars.

MR. BROWNING: That is all of the direct examination.

*Cross Examination*

BY MR. REYNOLDS:

Q Mr. Otis, this device of yours was designed to prevent freezing of the surface choke; isn't that right? A That is stated partially correctly.

87 Q For what other purpose was it? A It was to prevent—primarily, freezing at the surface choke at varying rates of withdrawal.

Q Would it have any value, in your opinion, other than in combination with a surface choke? A Yes.

Q What value? A Two values. Our crews are called upon quite frequently to change surface connections on high pressure wells. One apparently obvious way to do this is to set what we call a blank choke in the well and take all the differential across that choke. In the case of the high pressure wells that is a very dangerous and virtually impossible procedure because we are subjecting our packing element to the full pressure differential. So in a well, such as the Stanolind well at 7100 pounds, we would have a 7100 pound drop across the packing and the assembly and that packing would not withstand that pressure drop, and to get around that we set a series of regulators in this well, each regulator absorbing or taking up approximately 1500 pounds.

In the case of this one well that was shown in the pictures, which was 7100 pounds pressure, we would set five regulators in that string of tubing, each one taking off 1500 pounds of pressure, so that there would be no pressure left at the surface, and no one set of packing
88 would be subjected to more than 1500 pounds.

After putting these regulators in and bleeding the pressure to zero at the surface, we take off the connections, which are possibly corroded or eroded and dangerous, and replace them with new connections, and then pull out the regulators from the well, and the well is put on production again.

That is a considerable use of the regulator and does not include the surface choke.

Q Is that your suggestion in your application? A I don't know whether it is or not.

Q Did you ever actually use it in a system that didn't have a surface choke? A Yes, we did use it in systems in many cases where the surface regulator is employed in conjunction with it, and in some instances fed directly into the line without any choke.

Q How would a line like that be controlled if it didn't have a choke? A The well would be produced wide open through the regulator. I say wide open to the extent that the pressure differential across it would allow production. As the line pressure rises, volume goes down. Production would be increased as line pressure at the well is reduced, is lowered, indicating the need of more gas.

89 The differential across the regulator would tend to increase and the regulator would open wider to admit the passage of more gas.

Q What was it that raises and lowers pressure in that system? A The gas system?

Q Yes. A By the effect of other wells on it.

Q And the valves are assisting in that, too? A Of course, there are the valves; yes, sir.

Q Has the fixed choke valve on your patent number 1,920,103 ever been used commercially? A Yes, sir.

Q To what extent? A To a very considerable extent.

Q How would its use compare with the one on which you have an application? A This one in the application is rapidly and almost completely replacing the fixed choke.

Q Well, how would the total number of sales of the two up to now compare? A I don't know that I can answer that question. The fixed choke was on the market at least 17 years ago. That patent is about to run out. So that it has had a much longer experience.

It is not used to any great extent now in preventing freezing; this regulator having almost completely
90 replaced its use for that purpose.

Q Would you say that up to now more of these have been sold than under the application? A Yes, because it has been on the market so many more years.

Q You can use fixed chokes of different sizes and replace one by another? A Yes, we can pull them out and put in a new choke and rerun it.

Q These sales records that you have here, do they all relate to devices made in accordance with this application involved in this case? A That is correct.

Q That application discloses several forms of device. To which of these do those sales pertain? A They include all three forms shown in the application.

Q And you have personally examined these records? A I haven't examined all of them. I have spot checked them. They are kept by my own accounting department and by my own comptroller.

Q How do you know they relate to your own device? A By having checked through there and looked at several of them. I haven't looked at all of them, but I know that they indicate the type of tool involved
91 in the case.

Q But you feel convinced personally that all relates to this application? A I do.

Q Now, referring to this Bruce patent, that patent states that the device can be used to regulate the flow of all fluids, doesn't it? A It does.

Q And anyone using that would proportion it and design parts to fit the pressure with which it was to be used, would they not? A I presume they would.

Q In other words, a mechanic could adopt that for use with high pressure fluids? A In the use for which it is designed; yes.

Q Did you testify that that does not serve to maintain a substantially constant differential between the inlet and the outlet? A Yes, sir.

Q Now, suppose you were operating with one degree of vacuum and a higher vacuum is applied here. Wouldn't the effect be to open the valve wider? A Yes, sir.

Q Wouldn't that admit more air? A Yes, sir.

92 Q And wouldn't that reduce the vacuum? A It would tend to reduce the vacuum; yes.

Q So it does tend to maintain a constant differential? A No.

Q If it tends to lower the vacuum, doesn't that tend to get the pressure down? A But there is one other element that you haven't mentioned.

Q What is that? A Compression induced in the spring by the fact that the valve is opened wider, and that increases the compression and tends to increase the differential across the valve.

Q That is true in your device? A Only to a very slight extent.

Q Well, you are just assuming your spring is a different strength than his? A No, I am assuming the length of the spring and the spring strength is the same, and the length of the spring and the design of the valve is such that the increased differential induced into the spring by going from the fully closed to the fully effective open position is negligible.

Q Does your application give any dimensions or proportions of the spring? A No, sir.

93 Q Does Bruce give any dimensions or proportions of the spring of his structure? A No.

Q On what do you base your conclusion, just from a diagrammatical showing of the drawing? A Only partly. Bruce does mention some length, the fact that he has a long tapered valve element which changes in diameter gradually, bringing about gradual changes in rate of flow through it.

We certainly kept away from that in our design and in our invention.

Q Did you testify that the Bruce device tends to maintain a constant flow of fluid through the valve? A No, sir, I didn't testify about that.

Q Well, what do you conceive the purpose of that device is? A It is to admit air in varyng rates of flow, and the rate of flow passing through and controlled by the pressure differential across the valve element.

Q It is controlled at a rate which tends to maintain a constant differential? A Perhaps if you use the term tends a little loosely, you are correct.

Q What is the use in any way in which it does
94 not tend to? A It tends to a slight degree.

Q That is the only tendency it has, isn't it? A No, the fact that the valve opens and that the opening through the valve is occupied by a long tapered member simply implies that there must be a relatively high compression induced in the spring to get any appreciable change in rate of flow, and if that occurs there is considerable increase in the differential across the valve.

Q Can you point to any difference in operating principle between the Bruce and your device? A Yes, sir.

Q What is it? A Our valve, our valve element was designed to open very rapidly, in fact, just as rapidly as we can make it open. We don't try to get a gradual increase in the rate of flow through it. So the valve is designed to control pressures, not control rate of flow. We employ the spring long enough in conjunction with the opening of the valve so that the increased compression induced is negligible. Our valve is to control pressure. Our field is control of pressure. We don't have in mind its application for a tool which would gradually change rate of flow.

Q Don't you agree the Bruce valve is not de-
95 signed to change rate of flow? A No.

Q This does not change rate of flow? A Its function is designed to regulate rate of flow.

Q Dow does it regulate? A By means of pressure on either side or pressure differential across the valve.

Q Does it keep to a constant? A In the design shown.

Q How does it tend to regulate it? A By admitting more when there is more, and less when there is less.

Q Is that regulation? A Yes, that is regulation.

Q You think this does not regulate it? A Sir?

Q That valve does not regulate rate of flow? A It obviously, to some extent, regulates rate of flow, but its purpose and design is not primarily to regulate rate of flow but to regulate pressure and is set up as a predetermined pressure differential, setting up and maintaining of predetermined differential.

Q Now, suppose you gave that Bruce patent to a mechanic and told him you wanted a valve of that type designed to put into an oil well. Do you think he
96 could do it? A A valve of that type?

Q Yes. A You mean, precise type?

Q Yes. A A mechanic could design such a valve and build his element strong enough to stand up for a short time.

Q And if he did put it in a well, wouldn't it work substantially the same way yours does? A No, sir.

Q What would be the difference? A It would not permit—in the first place, it would not maintain a substantially constant pressure differential. In the second place, it would not permit an appreciable varied rate of production without freezing.

Q Why wouldn't it maintain a substantially constant differential? A Because of the long tapered valve element, as compared with the relatively short spring as shown there. You can even omit the spring out of the long tapered valve element. It is the element that makes that inoperative for our purpose.

Q Does that application show anything about the proportion of the valve element? A I don't believe it did include any discussion on that.

97 Q How did you expect a mechanic to know what proportions to make it then? A I believe you are getting into the matter of patents, and I am no authority on the wording of a patent.

Q How do you expect a mechanic to know how to proportion that valve from your application? A I think any good mechanic, if told the purpose of our valve, could go ahead and design it.

It is not a matter of proportion. It is a matter of making a quick opening valve, and the proportions of the square will enter the picture in the design of the spring as compared to the area for which the differential is determined.

Q Just imagine the Bruce valve to be installed in an oil well, and suppose that your surface valve is closed partly, that is, moved to a more nearly closed position. Now, that would be an increase of pressure on the downstream side of the choke, wouldn't it? A That is correct.

Q And the result of that would be, that the choke would open? A No, the result would be just the reverse. It would tend to close the valve.

Q That is right? The choke would tend to close? A That is correct.

Q And that will tend to maintain the same differential you had before, won't it? A It will tend to, except, however, to have a more predetermined effect and that is in that instance, a decreased differential that is set up in the spring, or the decrease of the differential which the spring brings about. 98

Q Why won't it maintain exactly the same differential? A Because you have movement of the spring, considerable movement. That is because of the extent it moves by variation in pressure.

Q That is true in your device too, isn't it? A Yes.

Q What is the difference of operation? A Our device is a quick opening valve without that tapered member shown there and with a long spring. It was designed with the length of the spring such that the valve in moving from the fully closed to the effective fully open position has virtually no change in difference of compression.

Q Well, doesn't it get around to this: that the difference between the two is in the tapered valve and the length of the spring? A In principle, yes, that is correct. There are, of course, other matters in the design that would render that incorrect.

Q Isn't it true neither your application nor the
99 Bruce application specifies any length of spring?
A Bruce does mention a long, gradual tapered
valve. A gradual rate of change was implied with considerable movement of the spring.

Q That application does not recite any particular valve or any particular length of spring, I don't believe, in so many words. A I don't know. We see the valve. It seems to have a certain particular bevel, so the spring must be of a certain length. I don't think we see here what went into the application. It would be within—it is within the scope of a good mechanic to design the type of valve we have built.

Q And the features you rely on to distinguish from the Bruce patent are not really described in your patent application? A I cannot answer that. That is not within my province.

Q Does your application—you read that? A Yes, sir.

Q Don't you know what is in it? A We have described a valve that will maintain a substantially constant pressure differential regardless of the rate of flow. It
should be rather obvious in my mind to any good
100 mechanic about what type of valve he had to build,
except the specific length of spring, or the taper or
bevel of that valve. That is, I don't think that you
can describe such a matter in a patent.

Q Well, if you gave a Bruce valve to a mechanic and told him you wanted to maintain a constant differential, he would know how to fix it? A The chances are he would throw it away and start over on the average job.

Q But he can do it by changing parts? A No, he is going to have to change the design from that type of valve to a quick opening valve. He is going to have to change the spring proportion, inasmuch as that valve has one shape and we definitely have another.

Q He would not change anything but the shape of the valve and the length of spring? A To make it an operative tool, he would.

Q What do you mean? A He is going to have to shield the spring from the flow impact, and with that spring as it is designed and put in a well, it is no exaggeration to say that spring would not last three minutes before it would be cut to pieces.

Another matter, incidentally, is the matter of the packing, and there is the matter of the extremely high velocities approaching supersonic speed, setting up a vibration, and there is the matter of the area under pressure
101 and the valve is just about all wrong.

Q Well, whatever changes were to be made, if you gave them to a mechanic and told him you wanted a valve to maintain a constant differential, he would know how to make it? A Well, I will tell you: I spent a lot of money and it took a long time to do it myself. I may not be rated as a skilled mechanic but it took me a long time to do it, and I spent a lot of money.

Q Do you want to say a good mechanic could not do it? A I will say a mechanic could design a valve that would function in principle as mentioned, but the refinements that must be put in to make it operative under the conditions of the well, that takes time.

However, the principles, the fact that you need a quick opening valve, and the long spring, those things are within the—well within the capacity of a good mechanic, those things.

But high pressure differentials, those are the refinements where you run into trouble.

Q Well, now, it was common knowledge in the art to keep the constant differential by the size of that bottom hole choke, wasn't it? A I can't say that was the case. No, it wasn't.

102 Q That would be the purpose of the Knowlton device, wouldn't it? A No.

Q What do you think he intended to accomplish by the hand regulation? A He suggested in his patent to take the full pressure at the bottom hole choke. He took his tool and dropped down to line pressure, with the exception of the pressure that was necessary to raise the gas from the choke and overcome the friction of flow in the tubing and up into the line. He didn't use the surface choke in conjunction with the bottom hole choke.

Q You say Knowlton doesn't use that choke? A He doesn't employ it. He doesn't use it in a high pressure well when he used it to prevent freezing.

Q He shows a choke in his patent? A Yes, sir.

Q And he mentions the desirability of preventing freezing? A Yes, sir.

Q And that is why he put the bottom hole choke in? A No, that wasn't his principal point. That wasn't what he was shooting for.

Q How does he prevent freezing? A He prevents freezing by taking all the drop across the bottom hole choke with none across the surface choke.

103 Q Then he did put a bottom hole choke in to prevent freezing? A That wasn't the principal purpose of the patent but he mentions he can do it.

Q And the patent, that result did regulate the bottom hole choke, didn't it? A He didn't attain it; no, sir.

Q He said he did attain it in his patent. A That he did say, that he could.

Q This patent says it prevents freezing? A Oh, yes.

Q And the way it purports to prevent freezing is by the movement of the bottom hole choke? A That is correct, by choking to a full differential giving the full drop at the bottom of the well.

Q And he indicates taking the full drop regardless of the position of the choke? A That is true but not regardless of the position.

Q But he has maintained a constant differential at the bottom line choke? A If you mean constant pressure, that does not exist if the valve is closed off.

Q Generally he is trying to do manually what you are trying to do automatically? A He was trying to do manually—I don't know how to answer that question.

104 Yes, he is trying to do manually what we are trying to do automaticaly, to some extent.

MR. REYNOLDS: That is all.

## *Redirect Examination*

BY MR. BROWNING:

Q Mr. Otis, please refer to the copy of the Bruce patent, 1,199,152, and turn to page 2 of the specifications, please, in column 1, beginning with line 9 and please read through line 29. A (Reading) "In the operation of the device, it will be seen that according to the vacuum created upon the outlet side of the valve, or an excess of pressure created upon the inlet side, the active member or disk-valve 4 will be drawn a greater or less extent toward the diminished end of 2, against the tension of the spring 17 and thereby, due to the tapering member 14 gradually narrowing as it approaches the diminished portion of the shell 2, the opening between the active member 4 and the tapering member 14 will increase, and thus the air drawn in through the perforations 10, will be more or less freely drawn in therethrough, according to the size of the opening between the active member 4 and the tapering member 14, which is determined by the variation of pressure, and proportioned by the adjustment of the tapering member 14, by means of its positioning."

105 MR. BROWNING: May I have Plaintiff's Exhibit 1, Your Honor? That is the file wrapper and contents. I believe Your Honor has it.

BY MR. BROWNING:

Q I hand you Plaintiff's Exhibit No. 1, the file wrapper and contents of your patent application involved in this action, and I refer you to page 28 of the original specifications of this application.

You will note that there is a part of that page indicated by brackets, apparently drawn in pencil in the margin of the original from which this copy was made.

Will you kindly read that portion indicated by the bracket?

THE COURT: Now, where is that taken from? Where is that?

MR. BROWNING: This is a certified copy of the record in the Patent Office, Your Honor.

THE COURT: Yes, but I mean what part of it is he reading?

MR. BROWNING: It is page 28 of the original specifications for this application.

THE COURT: Is that one of the specifications he is reading now?

MR. BROWNING: Yes, Your Honor.

THE COURT: Number 28?

MR| BROWNING: Page 28.

106 THE COURT: What is the number of the specification?

MR. BROWNING: Serial number 473,838. That is the application here involved in this case.

THE WITNESS: Should I read?

THE COURT: Very well.

That is a portion of the application that he is reading, is it?

MR. BROWNING: Yes, sir, it is part of the application.

THE COURT: Very well.

THE WITNESS (reading): "As hereinbefore pointed out, the main purpose of the regulator is to maintain a fixed pressure drop across the upper movable valve member and this involves regulation of the valve while it is open and fluid is flowing. While a predetermined pressure differential is necessary to open the valve, such a differential is also necessary to obtain automatic regulation while the valve is open. It is also pointed out that by making the spring relatively long, limited movements of the valve sleeve, which occur during the automatic operation, will cause little, if any, variations in the expansive force exerted by the spring. This is true because such movements are relatively slight."

BY MR. BROWNING:

Q Now, Mr. Otis, referring back to the Bruce patent, if a pressure differential were created across the Bruce valve so as to cause it to open and admit more
107 flow, and if as the result of that additional flow the
pressure differential which has been created was destroyed, or that the differential came back as it originally was, as counsel suggested to you a few minutes ago, would the valve remain open and permit flow? A I am not sure just how that question started. Start that over again. What I mean is the first part of the question.

MR. BROWNING: Will you read the question?

(The last question was read by the reporter.)

A No, sir.

BY MR. BROWNING:

Q Now, in the case of your valve, when the valve opens to permit flow, will it remain open and permit more flow, even if the pressure differential remains substantially constant? A Yes, if I understand your question correctly; yes, sir.

MR. BROWNING: That is all.

### *Recross Examination*

BY MR. REYNOLDS:

Q Did I understand you to say under such certain conditions the Bruce would not remain open to permit flow? A Yes, sir.

108 Q Under what conditions? A When the differential which caused it to open is removed, it will return to the closed position.

Q So would yours, wouldn't it? A If that differential is completely removed; yes, sir.

Q In your application where you refer to a relatively long spring, what do you mean by that, relative to what? A Relative to the length of the spring necessary to effect a substantially constant pressure reduction. That takes into account the areas under pressure and takes into account the rapidity with which the valve opens.

Q What is the basis of comparison? Relatively means as compared with something. It means relative to something.

I am trying to get the basis of comparison. A That gets into the matter of wording. That is pretty much of a play on words, it seems to me.

Q Well, you used the words. What do you mean by that? A Long as compared to the springs we are accustomed to, relatively long as to the springs we are accustomed to seeing in the tools in our industry and the oil industry. We employ springs, a great many springs in different types of tools and of varying lengths.

MR. REYNOLDS: That is all.

### *Further Redirect Examination*

BY MR. BROWNING:

109 Q Mr. Otis, does the length of this spring have anything to do with the necessary amount of movement of the movable valve element, to move it from closed to open position? A Repeat that, please.

Q Does the length of this spring in the regulator in order to accomplish that desired result have anything to do with the amount of the movement of that movable valve element from closed to open position? A Length of the spring—yes, sir. Now, that movement of the valve implies impressed compression in the spring, when the valve is moved to the open position.

If one spring is, roughly speaking, twice as long as the other spring, the amount of energy impressed in the valve for good movement is only half of that which is impressed into that with a shorter spring, or the increase in differential when changing the capacity of the valve so as to permit the flow when you are employing a long spring, it would only be half of the increase of the compression or pressure differential.

Q Then does the length of spring—is that controlled in any fashion by the amount of the necessary movement of the valve from closed to open position? A Is the length of spring controlled by the amount of the movement?

110 Q The length of the spring required for the desired result, is the length of spring you have to have controlled by the amount of movement of the valve to closed or open position? A Yes, sir. I see what you mean; yes, sir.

Q Will you tell us how that movement, the necessary movement of the valve has anything to do with the length of the spring? A The movement necessary to change the rate of admission is such movement—if you are opening, your valve will place compression into that spring. If that movement is considerable and you have a short spring, the compression placed in the spring will be relatively great, and the placing of the additional compression in the spring will incerase the pressure differential across the valve element. So if you employ a short spring, for a given movement there will be a considerably greater increase in differential across the valve element than would be the case if you employ a long spring, and since we want to keep our pressure differential substantially constant, we are forced to employ a long spring.

THE COURT: I will take this up at half past one again.

Now, how many more witnesses do you have, Mr. Browning?

MR. BROWNING: If your Honor please, we have two more witnesses and one deposition. The witnesses will not be as long as this one. They will be fairly short.

* * * *

MR. BROWNING: If the Court please, I have no further questions for this witness.

I should like to offer in evidence at this time the records of the Otis Pressure Control, Incorporated, that the witness produced, and I ask that that record be marked Plaintiff's Exhibit 6.

MR. REYNOLDS: No objection.

THE COURT: It may be admitted.

You don't expect me to read those, do you?

MR. BROWNING: No, Your Honor. I am only offering them to make them available for any check Your Honor would care to make, or opposing counsel.

THE COURT: I don't care to make any. I don't know whether Mr. Reynolds wants them.

112 MR. REYNOLDS: Do you have a list of them? I am willing to agree that the tabulation would be accurate.

THE COURT: Then just put in the tabulation.

MR. BROWNING: With the stipulation of counsel, I offer in evidence a tabulation made under the witness' supervision and at his request from the records of Otis Pressure Control, Inc., which he furnished.

THE COURT: Very well. It will be admitted. I don't see any use in admitting all these.

MR. BROWNING: Then I shall withdraw the original records themselves and substitute instead that tabulation and ask it be marked Plaintiff's Exhibit No. 6.

THE COURT: Very well.

(The document was thereupon received in evidence and marked Plaintiff's Exhibit No. 6.)

MR. BROWNING: I have no further questions.

MR. REYNOLDS: No questions.

* * * *

113 *Ira A. Miller,*

* * * *

*Direct Examination*

BY MR. SIMMS:

Q Will you please state your name and residence to the Court? A I. A. Miller, Dallas, Texas.

Q What is your employment, Mr. Miller? A General superintendent of field operations.

Q For whom? A For Otis Pressure Control, Inc.

Q What is the principal place of business of this company? A Dallas, Texas.

Q How long have you been with Otis Pressure Control? A Approximately 19 years, a little short.

Q Do you recall when you became associated with them, that is, the year? A In the latter part of 1930.

Q What was your occupation prior to 1930? A I was employed as a cable tool driller and tool dresser.

114 Q That is, in oil field operation work? A Yes.

Q In drilling of wells? A Yes.

Q What was your first position with Otis Pressure Control? A The first position was a helper.

Q How long did you stay in that capacity? A Oh, a few months.

Q What was your next position? A As a foreman.

Q How long did that last? A Approximately a couple of years.

Q What was your next position with the company? A District superintendent.

Q In what field or area were you district superintendent? A In the State of Oklahoma.

Q Was that from '34 to '39? A That is right.

Q What was your next position? A As a division superintendent.

Q What was the area which was included in your division? A The Gulf Coast.

115 Q Could you tell me what States that included in the Gulf Coast area? A Texas, Louisiana, and Mississippi.

Q And you were division superintendent from '39 to '45? A Correct.

Q Since '45 have you occupied the capacity of general superintendent in the majority of field operations? A That is right.

Q In your experience have you had occasion to be in a good number of oil producing fields and gas producing fields in the mid-continent area? A Yes, sir, I have.

Q Would you say the proportion of fields that you have been in in the entire mid-continent area? A I would say that is correct. Yes, I have been.

Q Would you state the proportion, that is what I asked you, that you say you have been in? A I have been in two-thirds of the fields.

Q In the entire mid-continent area? A I don't know that I would say entire mid-continent, but I would say in the lower mid-continent.

Q In the lower mid-continent area? A Yes.

Q That would include Oklahoma, Texas, and
116 Mississippi? A And Kansas.

Q And Kansas? A Yes, sir.

Q Do you know from your own experience what the gas produced in the fields is utilized for? A As a fuel and to manufacture gasoline.

Q When a gas well produces gas in the field, what does it discharge into? A A gathering system or a transmission line commonly called a trunk line.

Q Do you know the average pressures to be encountered in gathering lines or trunk lines for transporting gas for fuel purposes? A Yes, sir. It would run between 500 to 1200 pounds per square inch.

Q Now, if that gasoline is going into a gathering system, I mean, gas is going into the gathering system to be transported to a gasoline plane, what pressure would be likely to be encountered in the gathering system? A In cases where it is going into a gasoline plant, they would have higher pressure, small lines, and I have seen them up to 4,000 pounds.

Q In the Gulf Coast area, would you give an estimate
of the length of this Gulf Coast area in miles, the
117 length of territory that the whole area covers? A
Yes, sir. The high pressure area would be from the Rio Grande Valley to the Mississippi Delta, and approximately 600 miles, that is more or less a guess, about that.

Q What would be the width or an average width of that? A The average width would be between 100 and 200 miles.

Q Now, it is my understanding that the whole area is not covered with gas wells but that they are scattered throughout that area, over the fields in which gas is produced A That is correct.

Q In the Gulf Coast high pressure area, what is a normal pressure that you can expect to encounter in a gas producing well? A A normal pressure?

Q Say an average pressure? A Oh, an average pressure today would be 3,000 pounds per square inch.

Q What is the highest pressure you have ever encountered? A Over 8,000 pounds per square inch.

Q Do you commonly run into pressures in ex-
118 cess of 3,000 pounds? A Oh, yes, very commonly.

Q With a good deal of frequency? A Yes, quite frequently it is more than 3,000 pounds.

Q Would you say frequently, as high as 5,000? A 5,000 would be, begin to approach an average now.

Q A 7,000-pound well, is that an average well? A Not exactly.

Q But they are frequently encountered? A They are very frequent. It is not an average well.

Q When a well which is producing gas at one of these higher pressures, from three to five thousand pounds per square inch, is being produced into a gathering line for fuel purposes wherein pressure would not exceed 1,000 pounds per square inch, that is within the line, what was done prior to 1938 in order to put the high pressure into low pressure? A Well, there were two different systems, and one of them was a heater at the point of your restriction of your choke.

Q Perhaps we are getting ahead of ourselves.

Is it necessary to expand that gas to reduce that pressure before it can be introduced into the gathering system? A Yes, sir, it is.

Q How is that accomplished? A Well, that was accomplished by a heater.

Q Does the heater itself expand the gas or is
119 that— A (interposing) It is through restriction
or choke.

Q What occurs when that choke is located at the surface of the ground? A Well, if you are going from high pressure to low pressure, it will freeze up.

Q About what pressure differential has your experience led you to find that you can take across the surface choke before you commence to encounter freezing of the line? A Not to exceed a thousand pounds per square inch.

Q If the pressure differential across the surface choke exceeds that, freezing is likely to occur, as I understand it? A That is correct.

Q Now, the heaters that you mentioned, how are they employed in conjunction with the surface choke? A Well, you mean, how are they used?

Q Yes, sir. A Well, it is usually a coil through a sort of boiler, and the gas is permitted to pass through the coil in the well at the point of the restriction.

Q What is the purpose of that? A That is to warm the gas and prevent freezing.

Q And that was common practice prior to 1938? A Yes, sir, it was.

120 Q Is it common practice today? A Not too common.

Q But you do encounter it today? A I have encountered that; yes, sir.

Q Is there any other method for reducing the pressure from the well, that is, well pressure to a pressure which could be utilized in the gathering line that, to your knowledge, was employed prior to 1938? A Yes, sir, there was.

Q What was that other method? A The bottom hole choke, a fixed bottom hole choke.

Q Is it possible to produce a well through a fixed bottom hole choke so that you can vary the rate at which the well will produce? A No, sir, that is not possible. To my knowledge, it is not.

Q Is that possible to do with the heater? A Yes, that can be done.

Q That is accomplished? A Yes.

Q Then prior to 1938, if you are to produce a high pressure well in which the pressure within the well is sufficiently higher than the pressure within the gas gathering line, if that pressure drop were to take place across the surface choke, it would freeze. Was there any other
way, other than by the use of a heater, that that
121 well could be produced at a varying rate of flow?
A To my knowledge, there was not.

Q Is there ever any fluctuation in the demand for gas from a well? A Yes, sir, there is.

Q What accounts for that fluctuation? A Oh, the weather would be one of the main reasons. On a cold day you just use more gas.

Q On a hot day, you use less gas? A Yes, on a hot day you use less gas.

Q During any one day, would there ever be any occasion to vary that flow? A I think so. Personally, I think when everybody starts getting dinner, it would vary quite a bit.

Q And prior to 1938 that could only be accomplished, as far as your knowledge extends, by the use of a heater? A That is correct.

Q In the high pressure wells? A Yes, sir.

Q Are you familiar with the patent application of Messrs. Herbert C. Otis and John C. Luccous, serial number 473,838? A Yes, sir, I am.

Q Does your company, that is, the company with
which you are associated, Otis Pressure Control,
122 have any devices which answer or which are con-
structed in accordance with the teaching of that
application? A They do have; yes, sir.

Q Have you ever had opportunity to install any of those in a well? A Yes, sir, I have.

Q Would you estimate how many wells you have equipped with that type of apparatus? A It would be a guess, but I would say several hundred.

Q Do you think that might be as many as 500? A I would say more than 500 because some of that has been serviced more than once.

Q More than one time? A Yes.

Q By equipping a well, a high pressure gas well produced with a tubing with the regulator that you have referred to, is it possible to produce that well at varying rates of flow into a gas gathering line of much lesser pressure, that is, greater than 1,000 pounds differential in there, which would cause freezing, without freezing occurring? A Yes, sir; with the bottom hole regulator.

Q That is right? A Yes, sir, that is right. You can do that.

Q And within these wells that you spoke of, that
123 you have installed several hundred wells with such
equipment, have those wells performed so as to
eliminate the problem of freezing at the surface control?
A Yes, sir, they have.

Q And is it possible to vary the rate of withdrawal of gas from an individual well over a wide range when that well is equipped with this regulator? A Yes, sir, you can.

Q Without the occurrence of freezing at the surface control? A That is right.

Q Or freezing in any other portion of the well? A That is right; there would not be any signs of freezing.

Q Have you ever installed any of these bottom hole regulators in an oil well? A A few; yes.

Q Could you give the Court some idea of what you have in mind by a few? A Oh, some of that has been—there is probably more gas than oil, but, I would say, about maybe 100.

Q Possibly as many as 100? A That is right.

Q But these wells weren't actually producing
124 both gas and oil? A Well, sometimes they did.

Q In your experience in the field in the installation of those wells with bottom hole regulators, have you any opinion that is based upon your experience, do you have any opinion as to what is a good operating practice in regard to the pressure differential that any one regulator should be subjected to in operation? A Yes, sir, I do.

Q What would you say that opinion is? A But not to exceed over 1500 pounds.

Q If you had a well which was produced at such a pressure as compared to the gathering line in which it is to discharge, that if you reduced that pressure differential 1500 pounds with a single regulator you would still have more than 1,000 pounds to be dissipated across the surface choke, and therefore there would be danger of freezing, what would you do in that instance? A I would install another regulator.

Q Where would that other regulator be installed? A Oh, about a thousand feet above the first one and, of course, we didn't say how far it was.

Q Where is the usual customary place within the well to install the first one? A Oh, an average would be in the Gulf Coast area, about 6,000 feet.

125 Q I might say with regard to the producing formation, where would it be located? A That varies quite a bit, but usually from two to a thousand feet from the bottom, from 200 to 1,000 feet from the bottom.

Q I ask you the criteria you go by to select that location? A Well, we think that is—we don't like to get them any lower than necessary, and with that heat at that depth would be sufficient to prevent freezing.

Q Do you mean by that the temperatures at that depth would be great enough to provide some heating of the gas as it expands? A Yes, sir; that is right.

Q And the gas itself would be hot enough to stand some cooling without freezing? A That is right.

Q What is the greatest number of regulators that you have personally supervised installation of in a single well? A Four.

Q Four? A Yes.

Q Approximately what spacing did you maintain in that well between the individual regulators? A Approximately a thousand feet.

126 Q Between each pair? A Between each regulator.

Q Do you recall what the pressure of that well was? A That particular well was around 7,000 pounds.

Q Do you recall whether that fuel, this gas from that well was used as a fuel or taken to a gasoline plant? A From that particular well, it went into a line and I don't know what they were using it for.

Q You don't know that? A No.

Q Do you know what the pressure is? A I would say they were using it for a fuel.

Q But what was that pressure? A That pressure was, oh, just a few hundred pounds. I don't recall how much but very low.

Q It wasn't high pressure, less than a thousand pounds? A No, it wasn't high pressure.

Q Then you had a differential between the well and the gathering line pressure of at least 6,000 pounds per square inch; is that right? A Yes, sir; that is right.

Q And you installed four regulators within that well tubing? A That is right.

127 Q Were you able to operate that well so as not to cause freezing at the surface? A Yes, sir, into a line; yes, sir.

Q That well was operated with and in conjunction with a surface control, that is, a surface choke? A That is right.

Q In the operation of high pressure gas wells that you have worked on and installed the regulators that we are talking about, if it becomes necessary to vary that rate of flow, that is, the rate of withdrawal of gas from the well, how is that accomplished? A By usually an adjustable choke or valve.

Q Where is that valve or adjustable choke located? A At the well connections at the surface.

Q At the surface? A Yes, sir.

Q Then if you increase the opening of that adjustable choke or valve, what happens to the characteristic of flow, that is, the rate of withdrawal? A You get more gas.

Q And if you shut down down, you get less gas? A You get less gas; yes, sir.

Q In doing that what happens to the pressure differential across that regulator? A Oh, very little if anything happens to it.

128 Q It will remain substantially constant? A Yes, sir, it will.

Q Do you know of any use to which the regulator can be put, other than the control of gas from a high pressure well so as to prevent freezing? Does it have any other use? A Yes, sir, it does have.

Q Would you state what that use is, please? A Well, one use would be to keep an extremely high pressure off your surface connections.

Q Will you explain what you mean by that? A Yes, sir. A well that is having 7,000 pounds per square inch wouldn't be, what I think, is safe, due to well connections, especially, and the tubing, the tubing itself at the top.

So by installing the regulators, you cut down on the pressures, and, why, at the top you can get a lower pressure which would be more in line with what should be on the connections and tubing.

Q I think it is perhaps important to understand that statement, if I understand it, and for the Court to know a little bit about some of the well equipment. I want to examine you along that line.

In the first sheet of the drawings of the application, serial number 473,838, in Figure 1, and referring to Figure
1 we see schematically a well equipped with a cas-
129 ing and tubing. A Yes, sir.

Q This being the casing and this being the tubing? A Yes, sir.

Q This flow of gas from the high pressure wells we are discussing going up through the tubing? A Yes, sir, they do.

Q Now, is there anything, that is, other than what might be atmosphere, air, between the casing and the tubing? A Yes, sir. In high pressure wells there would be a column of mud or what we call fluid.

Q Is this mud mud that just happens to be there or something that is put there? A No, sir; that is drilling mud that is purposely left there.

Q What is its comparative density with water, as a rule? A As far as I know, oh, about 50 percent heavier than water?

Q How is that accomplished? A By a mixture of mud.

Q What is known as weighting material? A Yes, weighting material.

Q What purpose does that column of mud—let me ask you this:

130 Is that, incidentally, near the surface of the well or where? A It is held in place at the bottom of the well or close to the bottom of the well, above the formation, with the tubing, casing, and a packer, and at the top it is just full. That is all.

Q In other words, they fill this space between the tubing and the casing with the mud from the surface but a packer is near the bottom of the well? A That is right; yes, sir.

Q For the Court's information, will you explain where that packer is and what it does? A That packer, I would say,—

Q (Interposing) You might want to point to the drawings. A This packer was around in there (indicating). It would be held in place by an anchor or tubing which stayed on the bottom, or slips, which would be a set in casing.

Q Is that there for the purpose of providing a seal between the tubing and the casing? A Yes, sir, it is.

Q This weight of mud—you can take your seat again, sir.

This weight of mud, the column of mud that you

131 referred to, does it provide a pressure at the bottom of that column due to the weight of the column of mud which is greater than the pressure of the formation from which gas is produced? A That is right; yes, sir. This weight of that column is greater than the bottom hole pressure.

Q Then if you had a well, which I understand is common practice, that column of mud between the tubing and the casing extending from the surface down to this bottom hole packer, and the well had a pressure of 5,000 pounds per square inch, the mud would be adjusted so that the weight of the mud at the bottom of the hole would be more than that 5,000 pounds? A Yes, sir; that is right.

Q Now, if the pressure of the well were 7,000 pounds, would that column of mud have its weight adjusted so as to provide 7,000 pounds or more pressure at the bottom at the packer? A Yes, sir that would be heavier mud.

Q One of the purposes then is to give a substantially balanced differential across the packer; is that correct? A That is correct, and also to complete the seal.

Q So as to prevent flowing out of the well while you are running that tubing? A That is right.

Q If you had that column of mud in there, and you produced that well with a heater and a surface con-
132 trol only, no regulator or no bottom hole choke,
near the top of the well you would have then the tubing pressure equipment substantially to the pressure of the well; is that correct? A That is right. You would have the bottom hole pressure less the weight of your column of gas.

Q Now, on the outside of that tubing but within the casing, what would be the normal pressure at the surface of the well? A On the outside of the tubing?

Q Yes, but within the casing. A There would not be any pressure at all.

Q You mean atmospheric pressure or absolutely no pressure? A There would be atmospheric pressure.

Q Then you would have a pressure differential across the tubing of what at that point? A You would have your well pressure.

Q If that were so, your tubing would be subjected to that differential? A That is right; yes, sir.

Q What is the customary recommendation of tubing manufacturers for the pressure to which their tubing should be subjected? A The best grade—

133 Q (Interposing) For normal good practice? A The best grades of tubing would have a safe working rate not to exceed 3,000 pounds.

Q But using a heater only for the control of the freezing problem in the production of the high pressure well of 5,000 pounds per square inch, do I understand you would have across the tubing a differential of 5,000 pounds? A Yes, sir; that is right.

Q Now, are you able to protect that tubing from this excessive differential by the use of that bottom hole regulator we are referring to? A Yes, sir, I can.

Q Would you explain in your own words how you do that? A By staging them. A well with 5,000 pounds, we would move down low enough in the tubing to where the outside weight would be comparable, and we would take a reduction of 1500 pounds, and then move about another 1,000 feet and another 1500 pounds.

Q Then as the weight of the column of mud decreases, you would take a decrease in the differential of your producing column of gas? A That is right; yes, sir.

Q And that means are you able to install a well so that the tubing at no place will be subjected to a pressure differential of an unsafe or unwise practice? A Yes, sir; that is right.

134 Q Have you ever known of any other use of the regulator? A Yes, sir, I have.

Q What is that use? A To completely plug a tubing in order to remove surface connections for inspection or various purposes.

Q You mean close off the tubing? A Yes, sir, close it off completely.

Q So that you can remove the surface fittings without the use of a lubricator or any of this other special equipment? A That is right; yes, sir.

Q Do you know of any other way in which this has been accomplished in an oil field in all your experience? A No, sir, I don't. The only other way would be to kill that well, to pump in and kill it.

Q Let me ask you: If you have a well which is equipped with the bottom hole regulator for the purpose of relieving freezing, and you decide to close that well off so that your surface fittings can be removed for inspection, repaired, or whatnot, what would you have to do in order to accomplish that? A Install another regulator, one or more if necessary.

Q It would take an additional regulator or more? A An additional regulator or more is right.

135 Q So that the formation of the pressure differential across all of your regulators within the tubing would be as great as or greater than the pressure within the well? Is that what you had in mind? A That is right.

Q You referred a moment ago to killing the well. What does that term mean in the industry? A It would mean to put a fluid, a weighted fluid heavy enough to overcome the bottom hole pressure, and force it in the tubing.

Q Would that be fluid similar to this drilling mud? A Yes, sir.

Q Does that kill the well for future use of it? A Not necessarily; no, sir.

Q It means to render inactive that pressure in the ground so you can work with the surface fittings; is that your meaning A It means in a high pressure well with your packer set, it will be necessary to pump to a greater pressure than you already had, which would be an excess of 5,000 pounds. So you would have to overcome that 5,000 and probably a little more in order to put fluid back into it because the gas would have to go back in the formation, that was in the tubing.

Q You do that by pumping fluid into the well?
136 A Yes, sir.

Q How long does it take ordinarily in a 5,000 pound per square inch well to kill it by the use of mud? A If you are lucky, a couple of days.

Q But you always recover your well? A Not always; no, sir.

Q Is it a rare instance that you don't recover it? A That you would not recover it 100 percent. Lots of times you recover it but never as great as it was to start with.

Q In other words, its production capacity would not be as great as before you killed it? A That is right.

Q When you put it back into production? A That is right.

MR. SIMMS: That is all.

### *Cross Examination*

BY MR. REYNOLDS:

Q You mentioned shutting off a well by putting a series of these regulators into it. What advantage does that offer to fluid enclosing it? A By putting fluid in and closing it at 5,000 pounds would throw such a strain across your valve itself, or across the tubing at that point that it would not be practical.

137 Q Well, you could just cap the well, couldn't you? Don't they do that? A No, sir, not and take the connections off.

Q Why not? A Well, in one case we had, in the well they had a defect in the casting in the valve and had a small leak.

Well, it wasn't advisable to leave that leak. So there was no other way. There was no way to put any more on.

Q Don't they commonly close wells off by putting a cap on top of that? A Not if you have a leak in it.

Q But otherwise you could? A Well, it is already capped.

Q Well, then, what is the idea of putting these things down? A To repair the connections and put in one particular valve, and the bolts on the whole top of it. Every so often we have to plug that well and remove the connections, replace them, and seal the rings, and such.

Q Well, if you have a valve at the bottom of the well, such as shown in the Knowlton patent, could you close
that valve and that would take care of it? A Not likely
in the well we have been speaking about, with as much
as 5,000 pounds, and if that tubing wasn't in perfect
condition most certainly it would collapse or come close
to collapsing the tubing because the pressure from
138 the outside would be greater than that recommended
it should be on the API tubing.

MR. REYNOLDS: That is all.

MR. SIMMS: That is all.

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## 139 *Harry B. Schramm*

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### *Direct Examination*

BY MR. BROWNING:

Q You are Mr. Harry B. Schramm of Dallas, Texas, and you are employed by the Otis Engineering Corporation? A I am.

Q Please state what position you have with that corporation? A I am chief engineer.

Q What academic training have you had before going on your present job, Mr. Schramm? A I received a B. S. in petroleum production engineering from Texas A. and M. College.

Q When was that? A In 1937.

Q And what position did you go into when you graduated from Texas A. and M. College? A Immediately
after graduation from Texas A. and M., I worked in the
oil fields. It wasn't a position; it was more of a job
as roust-abouting and roughneck, and doing various
140 other work around the oil fields.

Q Would you explain the term roust-abouting and roughneck that you just used? A The terms are used, obviously, because they cover a number of duties, that of laying pipelines, doing what miscellaneous construction is necessary around an oil field, the repair of oil field equipment here and there, and anything that happens to come along. Mixed in among that was the work of construction of certain oil field equipment.

Q You are aware, I assume, that the term roughneck, colloquially, refers to a boorish or undesirable character. In oil field usage, does it have that meaning? A Not necessarily. It refers to a helper on a drilling rig. You see, the driller who operates the rig has helpers that are known in oil field language as roughnecks.

Q How long were you on this roughneck work that you speak of? A Upon roughnecking and the various other things about two years.

Q That is, various other things in the oil fields? A Yes, sir.

Q With whom were you employed in this work? A During that time I was employed by my father.

Q When you left that employment, what was
141 your next employment? A I was employed by
Joe H. Cable, a consulting firm in Wichita Falls, Texas, who deal almost altogether with secondary recovery methods involving the injection of gas and water in the depleted sands, and other sands which may or may not have been depleted, to increase ultimate production of crude oil.

Q How long were you in that employment? A One year.

Q What did you do in your next employment? A I was employed by the Fain-McGaha Oil Corporation as district engineer.

Q Where? A In West Central Texas.

Q How long were you in that employment? A For almost two years, until I was called into the Army.

Q What was your duty as district engineer? A I was sent to that district primarily to superintend the installation of gas gathering systems for their secondary recovery plants, that is, gas injection plants, and as assistant also to the district production superintendent.

Q Now, when you went into the Army, how long were you in service? A Approximately four years.

142 Q When you came out of service, what became your employment? A My position was still open to me. As a matter of fact, my firm and asked for me and actually speeded my return from the European Theater, but after taking a few weeks to look around and think things over, I decided that since the opportunity had offered itself to work for Otis Pressure Control, that I would change to that job.

Q Now, in your work for the Otis organization, which you say, I believe, is now that of chief engineer of the Otis Engineering Corporation, what are your duties in general? A In general it might be said that I have charge of all design engineering, testing and development, that is, testing within the plant itself, and development of new tools, improvement of all these tools, and I also act as assistant to the general manager of the company.

Q Are you familiar with the so-called Otis bottom hole regulator described and shown in the patent application which is involved in this action, which is serial number 473,838? A I am, sir.

Q What has been your contact with this device and your duties, if any, in connection therewith? A My duties have consisted of running a few of them in the field, but mostly have been concerned with the testing and designing and other work in regard to actual production of the regulator itself. 143

Q Are you familiar with the formulas and the methods used in actual practice in computing amounts of natural gases flowing through an orifice under given conditions? A I am, sir.

Q Or the required size of an orifice that would be required to produce a predetermined quantity of natural gas under given conditions? A Yes, sir.

Q Have you ever made any such computations in connection with the Otis bottom hole regulator? A Yes, sir, I have.

Q Based on your computations, can you tell us how much of a vertical movement of the sleeve valve element of the Otis standard 2-inch bottom hole regulator would be required to permit the passage of 3,000,000 cubic feet of gas per day when the pressure differential across the orifice is of the order of 1500 pounds, and the pressure upstream from the regulator is 5,000 pounds per square inch? A I am prepared to read that from a graph which I have prepared, if I may be permitted.

Q The graph was prepared by you based on your knowledge and experience in making calculations of this type? A That is correct, sir.

144 Q Will you do so, please? A A vertical lift of the movable, the upper movable valve member—

Q (Interposing) That is from closed position? A From closed position, yes, a lift of .047 of an inch would be required.

Q Translate that .047 of an inch, if you can, roughly into fractional parts of an inch, rather than decimal parts. A Into fractional parts; approximately three sixty-fourths of an inch.

Q Now, what would be the lift of that same element from the fully closed position to permit the passage of 5,000,000 cubic feet per day of natural gas, other conditions remaining the same? A A lift in that case of .063 inch would be required, or approximately one-sixteenth of an inch.

Q Now, can you give us the approximate cross-section area of that opening through which the gas would pass, that orifice through which the gas would pass in each of the instances I have just asked you about? A Yes, sir, I can.

From the same curve, the area needed for the passage of the 3,000,000 cubic feet of gas would be in the neighborhood of .023 of a square inch.

145 Q That is for 3,000,000? A That is for 3,000,000.

Q Now, for 5,000,000? A For 5,000,000 feet, the area necessary would be approximately .036 of a square inch.

Q Can you tell us from your calculations and have you calculated the approximate velocities of gas in this quantity flowing through an orifice of the size you have indicated? A Gas flowing through such an orifice at 5,000,000 cubic feet per day and under the conditions which were stated exceeds the speed of sound at atmospheric conditions, which we may assume to be approximately 1126 feet per second in the case of sound. In the case of the gas the calculated velocity is 1260 feet per second, or 860 miles an hour.

Q Do you know the length of the spring customarily used in the Otis standard bottom hole choke? A I do, sir.

In the bottom hole regulator?

Q In the bottom hole regulator. A Yes, sir, I do. It is 7 inches.

Q Then roughly what is the percentage of compression of the length of that spring from its closed position when the regulator is closed and open position, such as to permit the passage of 5,000,000 cubic feet of gas per
146 day? A I don't have any figure on that percentagewise.

However, we may easily see that the spring being 7 inches long, and a compression of only one-sixteenth of an inch being required to pass 5,000,000 feet, it would be in the neighborhood of—one-sixteenth, of course, which is only 6 percent of an inch.

Q Then you have 7 inches. A It would be one-seventh of 6 percent, or less than 1 percent.

Q Are you prepared to state the approximate elongation that will be caused in a string of 2-inch tubing such as used ordinarily in producing gas wells, hanging vertically due to its own weight, that is, the stretch of the tubing itself? A I am, sir.

Q If it were 5,000 feet, what would be the approximate stretch of the tubing? A I had it calculated here to 10, Mr. Browning.

Q You mean to 10,000? A 10,000 feet depth, and the length of stretch, if I may answer for that—

Q (Interposing) You may answer. A It is available here, and it would be 74 inches, or better than 6 feet.

Q What would be the approximate stretch, without trying to give an exact figure, what would be the
147 approximate stretch for 5,000 feet? A It would be less than half because the stretch varies with the square of the length of the tubing.

Q Now, in a 5,000 foot length of tubing, let us assume that the temperature of that tubing should change one degree Fahrenheit. Can you give us the approximate elongation or shortening of the tubing that would be caused by one degree change in temperature? A There again, if I may refer to my calculations?

Q Yes, sir, you may. A The change per thousand feet, per one degree change in Fahrenheit would be eighty-one-hundredths of an inch for 5,000, so it would be better than four-tenths of an inch.

Q For one degree change in temperature? A That is only approximate; yes.

Q Now, what would be, if you know, a reasonable average change in temperature to expect if you were producing 3,000,000 cubic feet of gas per day through an orifice at the bottom of such string of tubing, that is, 5,000 feet long, with the pressure below that orifice 5,000 pounds and the orifice of such size as to give you 1500 pounds reduction in pressure?

Can you tell us about the degree, the average degree of temperature rise or temperature change of that
148 length of tubing that you might expect? A That would have to be taken from experience as there

are many factors which affect it, but a temperature change that you might expect in such a string of tubing would be 50 degrees at a minimum.

That, of course, would depend upon your bottom hole temperature, but judging from the pressure which you gave, that bottom hole temperature would normally be well above 200.

Q And if you had that 50-degree change, do I understand that you would have 50 times such elongation or shortening of the tubing as you would with one degree change? A That is correct, sir.

Q That would be 50 times then four-tenths of an inch, or what would be the result? A Some 20 inches.

Q Approximately 20 inches? A Yes, sir.

Q Now, Mr. Schramm, I am going to ask you as a design engineer, based on your experiences in design engineering, whether the description that I am about to read to you would be sufficient, in your opinion, to enable a reasonably skilled design engineer in this field to design and build a valve in accordance with this description?

The description which I shall read is the wording of Claim 40 of application, serial number 473,838 that
149 is involved in this action. This is the description:

"A well fluid flow regulator including, a tubular body adapted to be located in a well and having a flow passage therethrough, a valve seat element in the body having a flow passage communicating with the flow passage of the body, a valve flow restricting element in the body acting with the seat element to regulate flow upwardly of the well fluid through the body, one of the valve elements being movable toward and from the other valve element and having uncovered opposite areas exposed to direct contact with the well fluid flowing through the passage of said body, whereby fluid pressures below and above said movable valve element are directly exerted thereon, and means acting on the movable valve element to resist movement of said element to create a predeter-

mined flowing pressure differential thereacross, said resisting means acting to automatically adjust the movable valve element to regulate flow through the valve seat to maintain a sustantially predetermined pressure reduction across the valve elements when the rate of withdrawal of well fluid flowing through the body is varied." A Your question being, do I think a trained engineer or trained design engineer from that given description could construct a valve which would serve the purpose stated in
the patent?

150 Q Yes. A It is my opinion that one of my
own engineers—of course, I know them better than
others, could construct such valve from that description.

Q Have you made calculations—first, let me ask you this:

Are you familiar with the Bruce patent number 1,199,152? A I am, sir.

Q Have you studied that patent? A I have.

Q Have you found anything in that patent teaching the use anywhere of a pressure regulator adapted to maintain a substantially constant pressure reduction for varying rates of flow? A I have not.

Q Have you made calculations based upon, based on your knowledge and experience in the field, to determine whether a regulator could be constructed with the proportions and the characteristics taught by the Bruce patent which could be placed in a well and made to operate over the rates of flow which the Otis bottom hole regulator is commonly called upon to handle? A I have, sir.

Q In making such calculations, are there any variables
which cannot be exactly foretold and must never-
151 theless be taken into account? A Yes, sir, there
are.

Q In selecting the values for such variables, what was your procedure? A Those values were chosen with the idea of giving the Bruce valve a very favorable chance to operate.

Q What was the result of your calculations? A My conclusion regarding the valve as shown and as rearranged was that it could not be made to maintain a constant differential over varying rates of flow.

Q In what respect did you conclude that such valve would fail to operate satisfactorily? A First of all, it would not maintain a constant differential. It would not be able to withstand the velocities which would be set up within the valve due to its operation, and the spring which would be used in the valve would be ruined due to over stress by the high differentials which would be placed across it, and the packing would be subjected to something in excess of 1600 pounds.

Q Do I understand from your testimony that if such a valve were set in a given initial pressure differential, and it would be required to crack it open, that upon being opened to permit gas to flow that the Otis regulator is normally called upon to handle, that the pressure differential across the valve would increase materially?
152 A It would, sir.

Q Now, you spoke of velocities. Would these excessive velocities be caused by the initial 1500 pound differential, let us say? A They would be caused by the increased differential which would be set up.

MR. BROWNING: That is all.

THE COURT: How long will you take?

MR. REYNOLDS: Five or ten minutes, Your Honor, I think.

THE COURT: I am going to sit ten minutes longer.

MR. REYNOLDS: I don't think I will take longer than that.

*Cross Examination*

BY MR. REYNOLDS:

Q In this Bruce patent, what determines the position of the partition between the two parts of the casing? A Of the valve itself?

Q Yes. A In the Bruce valve that position is determined by the differential placed across it.

Q In other words, the valve takes such position that the pressure on one side, plus the pressure of the spring, will be equal to the pressure on the other side; 153 isn't that right? A Well, if the valve is in equilibrium, these forces act on either side of it.

Q And one side will have pressure, and the other side pressure plus the spring? A That is true.

Q Now, if the spring exerts constant force then it will keep these two pressures at a constant differential? A It will not exert constant force.

Q But if it does? A We have tried to build a spring like that and it could not be done.

Q Can you say to me you cannot build one? A We tried awfully hard and we gave it up as a bad job; you cannot build a spring which will have a given rate over a part of its travel and then have that rate flatten out.

Q This spring in the Otis device doesn't have a fixed resistance either, does it? A No, sir.

Q And the differential will vary in that? A Yes, but the variation is negligible in the case of the regulator due to the very principle upon which it is constructed.

Q Let us put it this way: The pressure differential in Bruce will only vary by the amount of the resistance that the spring varies? That is true, isn't it? 154-155 A That is true.

Q And that is also true in the Otis device? A that is true.

Q But you think that the resistance of the spring in Bruce varies more than the spring in Otis? A There is reason for that belief.

Q Just answer the question. You think it does? A Yes, sir.

Q Did you testify that you think a skilled mechanic could not adopt this Bruce device? A I haven't so testified but I will; yes, sir.

Q What would be the difficulty? A His difficulty would be that he would be starting out with an entirely different principle, the Bruce valve having been built for an entirely different purpose. The descripton of the patent goes into great detail and has given the purpose of his patent. If the Bruce valve was constructed so as to work as this regulator, it would amount to doing away with the entire thing and starting over, and the result would not work in the carburetor as Bruce had anticipated.

Q Well, now, Bruce is not for a carburetor? A Not necessarily, but it is set up to do a certain job, and it would no longer do that job if it were made or, we will say, just transformed into another device.

156 Q He said it is designed for general use, doesn't he? A Yes, he does say general use.

Q And if he were to use it at a higher pressure, he would use a heavier spring? A He would use a heavier spring. He would not accomplish his purpose.

Q Is that mechanic that cannot make this one work, is he the same one that can make the one in Claim 40? A It might be, but I believe any mechanic starting out to build such a device as we have described here would not be able to because it started out to accomplish a different purpose.

Q What is the different purpose that Bruce is accomplishing? A Bruce's purpose is evidenced almost immediately in the description of the long metering pin, that purpose being, that this metering pin, by being long, controls volume. It allows a small increase of the volume per unit movement of the spring.

If he controls volume—now, mind you, he doesn't say how he maintains the constant volume, he controls volume, and by virtue of that, he cannot maintain a constant or substantially constant differential.

Q Well, now, the higher you get, the wider his valve will open? A That is true. 157

Q Does that control flow of air? A That controls the air which comes through there. If he had intended not to control the volume of air which comes through, he would have chopped off the long needle and have used a cap, but that would not work on a manifold, such as on an automobile, or any other manifold because the immediate inrush and volume of air would have made the mixture so lean it would kill the motor.

Q Well, the way he controls it, didn't he get more air with this valve or less if it weren't there? A He should get less change in volume of air per unit movement of that needle.

Q Just one queston. You said you get a 20-inch expansion in the paper in the 5,000-foot well; is that right? A That is approximately right.

Q How is that taken up? What happens to it? A That expansion?

Q Yes. A The tube actually stretches. My authority on that is the handbook of Zaba & Doherty, and Spang-Chalfant, who are one of the most outstanding manufacturers of tubular casing. It is the tried and accepted formula throughout the steel and oil industry.

Q What happens to the increase in length of the
158 tubing? A The increase in the length of the
tubing is sometimes—it would be in a manner which is called corkscrewing for the tubing must stretch, and it has only a certain amount of room and that means the tubing must lean over to one side and then to the other side of the casing, and sometimes it almost forms an actual corkscrew.

Q So the bottom of the tube would not actually move 20 inches? A In case you had a packer you would get a corkscrew, but in case your tubing hangs free, such as it would have to do in the case of the Knowlton patent, it would actually stretch and become longer.

MR. REYNOLDS: That is all.

* * * *

160 MR. BROWNING: If it please Your Honor, the other day at the beginning of this case I tendered in evidence the three prior patents upon which the Patent Office is relying. I am not sure that they are properly in evidence, and I would like to formally offer the three prior patents in evidence at this time. I have a book that contains copies of them.

I think Mr. Reynolds put them in evidence.

THE COURT: Very well. Is that correct, Mr. Reynolds?

MR. REYNOLDS: Yes, sir.

MR. BROWNING: I am going to ask my partner, Mr. Simms, to offer the deposition of Mr. Donald R. Knowlton.

MR. SIMMS: There is a deposition on file of Donald R. Knowlton, Your Honor.

THE COURT: If you want to read it, one of you take a seat in the witness chair and read the answers and the other the questions.

MR. SIMMS: We wish to offer that in evidence at this time. In order to save the Court's time, we are going to summarize parts of it, but due to the importance of this witness, we will read in part from the deposition also.

The deposition of Donald R. Knowlton, of Oklahoma
City, Oklahoma, was taken on the 23rd day of February,
1949, with James B. Simms and W. W. Cochran, the lat-
ter being Soliicitor for the United States Patent
161 Office, appearing as attorneys for the parties respectively.

Mr. Knowlton testified under subpoena that his office address in Oklahoma City was 2507 First National Building. That his formal education includes a degree in geology from the University of Colorado in 1920, and a petroleum engineering degree from Stanford University in 1924. His vocational experience in the oil industry extends 29 years, including service wth the Phillips Petroleum Company, whose headquarters are at Bartlesville, Oklahoma, from 1926 through 1946.

He entered the employ of Phillips Petroleum Company as chief engineer, then became superintendent of production and then production manager. The day after the attack on Pearl Harbor, that is December 8, 1941, he was placed on loan by Phillips Petroleum Company to the Government of the United States, at which time he occupied the position of National Director of the Production Division of the Petroleum Administration for War. He held this position two and a half years until June, 1944, at which time he returned to the Phillips Petroleum Company, serving as manager of their Foreign Production Department until his resignation from that company in April, 1946.

Upon resigning from Phillips Petroleum Company, he organized the firm doing business as Knowlton Engineering Company, serving as petroleum consultants,
162 which business he headed at the time of the taking of the deposition and whose address is that given, namely, 2507 First National Building, Oklahoma City, Oklahoma.

While serving with the Phillips Petroleum Company as chief engineer from 1926 to 1932, the nature of his work was more or less technical and he was in charge of all the technical work of the Phillips Petroleum Company in the production department. As production manager, he was in charge of the production operations including the engineering and operation of the production department. While in the Petroleum Administration for War, his activities covered the entire production operations of the domestic end of the oil business, including both the engineering and the production matters incident to that. The activities of Knowlton Engineering Company has been general relating to all phases of petroleum engineering including evaluation and appraisal work, unitization and secondary recovery.

Mr. Knowlton identified Plaintiff's Exhibit A, attached and made part of this deposition, as a copy of patent 1,905,592. He identified himself as being the same person

as Donald R. Knowlton, one of the inventors of the patent and that the other inventor, Wilbur J. Crites, is deceased. He testified that this patent was applied for at the time he was in the employ of Phillips Petroleum Company and that the application was assigned to
163 that company and as far as he knows is still owned by that company.

This patent 1,905,592, the large printed drawing, has been before the Court throughout this hearing.

THE COURT: Mr. Reynolds, did you take back your copy?

MR. REYNOLDS: Yes, sir (handing a document to the Court).

THE COURT: All right.

MR. SIMMS: The testimony then establishes that the chief purpose or object that he had in mind in the making of the patented invention was to provide apparatus for reducing the gas-oil ratio in wells, that is, to produce the least amount of gas with each barrel of oil and to provide a device that would control the gas-oil ratios by choking the well at the bottom and at the top and controlling the type of flow from the well with the particular aim to obain efficient flow from the well.

The witness testified that it occurred to him that the device of the patented invention would also serve a good purpose in controlling the freezing effect that occurs at the surface in producing high pressure wells because he had known that bottom hole choking was effective for that purpose when flowed at a constant rate and felt that this device might well serve that purpose.

The Phillips Petroleum Company actually installed equipment essentially as shown in the patent drawing,
164 namely Figure 1 of patent 1,905,592, in two wells, one of the wells was in West Texas in the Yates pool and the other was in the Oklahoma City field in Oklahoma. The installation in the Yates pool was in the spring of 1933 in about April. The well had a

depth of approximately 3100 feet and the installation had part for part the same elements or members as shown in Figure 1 of the patent drawing but the proportions were a little different than those indicated in the patent drawing for the sizes of the parts of the installation were made to comply with the type of equipment used in that particular producing well. The installation was made under the witness' actual supervision, the witness being present at the well, and the test conducted at this well extended for at least four months and probably six months.

The Yates pool installation included a valve located at approximately the bottom of the well in the tubing string having a stationary valve member 12 and a sleeve member 13 movable relative to the valve member, these parts serving as a valve to open or close the size of the orifice provided between the two parts. The movable sleeve was secured to the tubing string 20 and the tubing string was supported at the surface by a manually operated screw jack with a member 33 which could be turned in one direction to raise the tubing and thereby raise the sleeve or turned in the other direction to lower the tubing and thereby lower the sleeve. This
165 screw jack and the tubing string, about three-fifths of a mile long, was the apparatus provided for raising or lowering the sleeve which opens or closes the orifice provided between the sleeve and the shoulder 15 of the needle valve element.

At this time we want to read from the deposition at page 13, Your Honor, commencing with the first question at the top of the page.

"Question: Then, the sleeve 13 was connected to the part 33 through a mechanism including about 3,000 feet of pipe, that is, the tubing?

"Answer: Yes; the distance from the screw-jack which actuated the valve or choke at the bottom was approximately 3,000 feet, yes.

"Question: The tubing might be considered as a 3,000 foot valve stem, is that right?

"Answer: Well, I suppose it could be thought of in that way. It actually is the device or the means by which the valve is opened, is this 3,000 feet of tubing, that is correct."

We will now skip to the bottom of that page, to the last question on the page:

"Question: In operating the test well in the Yates field, equipped with the equipment that you have just described, if you wished to raise the movable member or sleeve which was comparable to the part 13 of
166 the patent drawing, that was accomplished, as I understand your past testimony, by a manual turning of a part comparable to member 33, and the two parts were separated roughly three-fifths of a mile?

"Answer: Yes, that's correct.

"Question: Would there be any influences encountered in the well, or were there any influences in that particular well, which would tend to change the length of that pipe string or tubing string, in the normal course of production?

"Answer: Do you mean without actuating?

"Question: Other than the screw-jack.

"Answer: Other than the screw-jack? Well, we did find in our operation of this well that the cooling effect of producing the well at various gas-oil ratios did have an effect.

"Question: What would cause the cooling?

"Answer: Well, the cooling is caused by the expansion of the gas as it passes by the orifice.

"Question: When you state orifice, just what do you mean by orifice?

"Answer: Well, I am talking now about the orifice as the bottom hole choke between the shoulder and the needle of this device we have in the bottom of the well.

"Question: That would be the ring-like space between the shoulder 14—

"Answer: Yes.

167 "Question: —and the outer surface of the needle valve that confronted that shoulder?

"Answer: Yes, that's correct.

"Question: At the particular setting?

"Answer: Yes.

"Question: That is the orifice?

"Answer: That is the orifice; that is what we call the bottom hole choke, that is, the choke at the bottom of the well; and as the fluid passes through that, the pressures being greater, of course, at the bottom of the well than they are on the upstream of the choke, the gas expansion naturally cools the stream of the mixture of oil and gas and it would cool the pipe or the tubing upstream from the choke."

Then by Mr. Cochran, who is appearing for the Patent Office:

"May I interpose to say that perhaps the witness is confusing the term 'upstream' here. I think the term as used in the application, upstream means really down below the valve."

Now, I suggest that we skip to the top of page 16, the question by Mr. Simms:

"Question: By upstream, as you used the word previously, you meant at a position higher or nearer the ground surface, which would actually be downstream from the flow sense? 168

"Answer: It certainly would, yes.

"Question: What would be the effect of the cooled well fluids that you have just referred to?

"Answer: The cooling effect of the expansion of the gas apparently or did have a tendency to cool the tubing and have an action of shrinking and contracting the tubing and actually raising the seat off of the stationary needle or valve.

"Question: That would give you a change in the setting of your bottom hole orifice, then?

“Answer: Yes, it would, depending upon the amount of cooling or the amount of expansion across the orifice.

“Question: Did you find in your operations down there in the Yates field, Texas, that if you would make a manual adjustment of the bottom hole valve to the place that you thought you wanted it, that there would ever be a change in the position of those members, caused by something other than a manipulation of the screw-jack?

“Answer: Well, we found out definitely that it did change that opening, depending upon the gas-oil ratio or relative amount of gas or oil that was produced by the well.

“Question: Let me ask you this. The needle member that was employed had to be what length?

“Answer: The one we put in first had about
169 four inches in length.

“Question: That is the taper?

“Answer: Yes, the taper from the seat to the tip was approximately four inches, which is essentially as is shown in the drawing here.

“Question: Did you do anything to that tip in order to attempt to compensate for this cooling effect that you found?

“Answer: Yes, in order to try to overcome that difficulty of contraction of the tubing, we built a number of needles with about a 12-inch taper, rather than the four inches shown here, in order that it would not be so delicate in adjustment, and that if there was some expansion or contraction in the tubing, it would not have such an immediate effect or such a delicate effect on our adjustment.

“Question: Do you mean by that, that where you used the long tip of about 12 inches, where the taper extended over about three times the length of the other taper, that a shift of the position of the moveable member 13 would have a less critical effect upon the size of the orifice?

“Answer: Yes, that's what I mean to say, that it would have a less critical effect. In other words, a movement, a vertical movement of two or three inches with the long needle would have a much less effect than two or three inches of movement with the short needle.

170 "Question: Did you experience any difficulty in setting that valve so that you got the orifice size you wanted?

"Answer: Do you mean this longer valve?

"Question: The longer or the shorter, either?

"Answer: Well, as far as setting it to a certain size orifice?

"Question: Yes, sir.

"Answer: Well, when the, of course, when the well was shut off, then, as we started to produce the well, we never could determine exactly the size of the opening because of this contraction of the tubing. It was a matter of experiment.

"Question: There was nothing at the ground surface in the way of an indicator that would show you the exact position of the moveable member relative to the bean?

"Answer: No, there wasn't any way to do that. We could tell by the gas-oil ratio at the surface whether or not we were having a cooling, because of the amount of gas being produced with the oil, but we couldn't calculate exactly what the size of the opening was at the bottom."

I want to summarize some more here, Your Honor. Summarizing again, the testimony was to the effect that in the Oklahoma City field there was an installation made in a well approximately 6400 feet deep identical with that which was installed in the Yates field except that in
171 place of the manually operated jack for lifting and lowering the tubing string, they used a hydraulic device located at the surface to lower and raise the tubing, and that is in place of this manual jack which required mechanical turning of the member 33 to elevate the tubing. Now, in place of the one-inch tubing, it was a 2½ inch tubing, and in place of the 3100 feet long, it was 6400 feet long,

and it being recognized that it needed more mechanical advantage at the surface in order to lower and raise that tubing.

The hydraulic device employed was that disclosed in United States patent 1,913,489, dated June 13, 1933 and identified by the witness as being a patent which he, Donald R. Knowlton, was one of the inventors along with Wilbur J. Crites. This patent was offered in evidence in the deposition as Plaintiff's Exhibit "B" without objection by Mr. Cochran.

The installation of the test equipment in the Oklahoma City field well was commenced about two months after the installation of the Yates pool well and was under the supervision of the witness, one of the inventors, who appeared many times at the well during the installation and testing of the well. The installation included a movable part and a stationary part located near the bottom of the hole, that is about 6400 feet or one and one-fifth mile deep in the earth and the tubing string again provided a
172 connection between the movable member and the lift equipment at the surface of the well. The orifice size at the bottom hole choke or valve was changed by lifting or lowering the entire length of the tubing string, that is about a mile and one-fifth.

We wish to read some more from the deposition, at page 21, Your Honor, with the last question on that page:

"Question: Did you experience any difficulty in making your settings of the orifice size of the bottom hole choke, in the Oklahoma City installations?

"Answer: Yes, we had the same trouble here that we had at the Yates pool, although we started out in Oklahoma City with the long tapered needle of approximately 12 inches in length, but we still had this same difficulty of the cooling effect and the construction of the tubing string, making it difficult to regulate the opening of the bottom hole choke.

"Question: Was there any surface indicator on the Oklahoma City installation which would indicate the orifice size or the position of the moveable member along the taper of the needle?

"Answer: No, there is no way that we could figure to do that. We had an indicator at the top to show how far up and down the jack went but, of course, that didn't indicate how much opening there was in the bottom hole choke.

173 "Question: In Figure 2 of the Patent No. 1,913,489, there appears to be a scale, 47, with an indicator arm 45.

"Answer: Yes, sir.

"Question: What would that indicate?

"Answer: Well, that merely indicates the movement of the jack member itself.

"Question: What number is that on the drawing?

"Answer: 26. It would indicate the movement of that jack.

"Question: That jack member was over a mile from the moveable member?

"Answer: Yes, sir, it was.

"Question: Did you, when you encountered the difficulty of adjusting the orifice size and maintaining that adjustment because of the cooling effect of the expanding gas past the orifice, did you try to think of any means that you might overcome that difficulty?

"Answer: Yes, we thought that there might be some way of thermally controlling it with a thermostat so that the adjustments of cooling and heating might be taken into account; but we didn't build anything of that kind.

"Question: You didn't make any installation like that?

"Answer: But we thought that might correct the thing. That was our principal difficulty.

174 "Question: Did you have any difficulty with longevity of life of any of the parts in the choke, that is, the needle or the sleeve?

"Answer: Well, here in Oklahoma City the wells have a lot of floating sand. The sand is very loose in Oklahoma City, and we produced large volumes of sand with the oil, and in this case here we had a lot of cutting action on this needle, and in fact, we replaced the needle several times, put new ones in, and found in removing the needle that there was considerable cutting action on the needle.

"Question: What part of the needle was cut?

"Answer: Well, it was cut right from the seat, where the seat 15 is in the drawing.

"Question: That is of which patent?

"Answer: That is on Patent No. 1,905,592.

"Question: From that seat, 15, to where?

"Answer: Particularly there, up to say half way up the length of the needle.

"Question: That is, the tapered length?

"Answer: The tapered part of the needle. The sand passing through there, due to the increased velocity as it passes the orifice, had a considerable cutting action.

"Question: Did you actually pull some of those devices out of the bottom of the hole, and did you see them yourself?

"Answer: Yes, sir, I did.

"Question: Were you ever at that well?

175 "Answer: I was there a great deal of the time. Yes, I was in Oklahoma City most of the time at that particular time. And as I say, I think it was, well, it was four or five of those, at least, that were put back in, and they all had this cutting action by the sand, the production of sand.

"Question: But was the cutting action of such character as to be a real detriment; I mean would you still get a practical life span on an individual needle?

"Answer: Well, it was, it was rather bad. It would last, in some instances it would last several days or a week. It depends on how long and at what rate you produce the oil, as to how much cutting you might have.

But it was a serious difficulty in the Oklahoma City field.

"Question: What would it cost to remove an old needle member, roughly, how long would it take, and replace it with a new one, or what was involved?

"Answer: Of course, you have to pull the entire string of tubing and release the member that's fastened into the bottom of the tubing.

"Question: When you would do that, would the well be in production?

"Answer: No, it would not, it would be shut down at that time.

"Question: About how long does it take to remove a string of tubing?

176 "Answer: Well, at that depth, it would ordinarily take a matter of a day or two to take it out and put it back, and that is providing that the well is not flowing. If the well is actually flowing, you would have to kill the well or pull it in and out under pressure.

"Question: Is that known as a snubbing action?

"Answer: Yes, sir, it is known as a snubbing action. It would be quite an operation.

"Question: Is there any danger attached to the snubbing action?

"Answer: Yes, there is quite a bit.

"Question: Of what nature?

"Answer: Well, there is the danger of fire, of course. When you have a live well and you are trying to snub the tubing, as we call it, in and out of the hole under pressure, any sparks or any friction in doing that operation has caused fires in many instances.

"Question: Was this device removed on the tubing string itself, or did it take a separate tool to run down and grab it?

"Answer: No, in this case here, we would just remove the tubing and this came up with the tubing.

"Question: Mr. Knowlton, do you know what disposition was made of the apparatus that was installed in the

Yates field well and the Oklahoma City field well,
177 that you have just described?

"Answer: Well, as far as I know, they were both disposed of as junk. In other words, they were not used to my knowledge after these tests were completed.

"Question: Were those wells produced after the discontinuance of these tests?

"Answer: Oh, yes, they were both produced under ordinary methods.

"Question: Do you know of the Phillips Petroleum Company ever installing apparatus in any other well in accordance with the invention of Patent No. 1,905,592 or Patent No. 1,913,489?

"Answer: No, I don't think anything was ever manufactured later on under those patents.

"Question: Do you know of any installations by anybody else?

"Answer: No, I do not.

"Question: Referring again to the cutting out of the needle, 12 in the Oklahoma City field, could you install the bottom hole chokes of your invention in a stage setup, that is, more than one of them in the hole and at different levels spaced along the hole, so that a pressure drop could take place across each of the devices?

"Answer: Well, I don't, I don't think it would be practical; I don't see any way of doing that.

178 "Question: You didn't make any installation like that on that test?

"Answer: No. No, to my knowledge, I don't remember even considering that method or that approach.

"Question: Are you famiilar with the device manufactured and sold by Otis Pressure Control and Otis Engineering Corporation, which is an adjustable bottom hole choke—it isn't adjustable, it is an automatic bottom hole choke used in conjunction with a manual choke at the top of the well; are you familiar with that apparatus?

"Answer: Yes; the one that they use in gas wells essentially, is that the one?

"Question: That's the one I have reference to, yes, sir.

"Answer: Where they use maybe one or more placed in the well?

"Question: Yes, sir.

"Answer: Yes, I know what that is, yes.

"Question: Is that ever installed in a stage installation, to your knowledge?

"Answer: Yes, I am sure it is.

"Question: Would that reduce the flow velocity past any individual valve on a stage?

"Answer: Well, of course, that is the object of it, yes, is to reduce the pressure by stages, rather than reducing it all at once across an orifice. 179

"Question: And that would slow down the velocity of the flow of the fluid through the orifice?

"Answer: Yes, it naturally would.

"Question: Would that have any effect on the cutting action of the fluid?

"Answer: Yes, it would. Of course, the cutting action depends on the velocities to a great extent.

"Question: What effect would that have?

"Answer: Well, it would reduce the cutting action in relationship to the velocities, of course.

"Question: Have you ever known of an installation in accordance with your invention of the two patents, identified as plaintiff's Exhibit 'A' and plaintiff's Exhibit 'B,' having ever been made in a gas well?

"Answer: No, I don't. These two that I speak of, the one in the Yates pool and the one in the Oklahoma City pool, to my knowledge, are the only two that have ever been installed, and both of these wells were essentially oil wells. The Oklahoma City well had more gas than the well in the Yates pool, it had a higher gas-oil ratio, but it was essentially an oil well."

And I wish to summarize some more testimony at this point, Your Honor.

On cross examination conducted by Mr. Cochran,
180 then the Solicitor for the Patent Office, Mr. Knowlton reiterated that the use of the invention covered by United States patent 1,905,592 on high pressure gas wells where the freezing of surface control equipment is a serious problem was one of the things which the inventors thought the device was applicable to. However, the main objective was to reduce the gas-oil ratios in high ratio wells.

The adjustment of sleeve 13 of Plaintiff's Exhibit A, that is, the movable sleeve here, with any degree of accuracy was stated to be very difficult because of the cooling due to the expansion which causes the entire tubing string to cool and lift the sleeve 13 upward from the seat, enlarging the annular orifice between the sleeve and needle 12. The freezing or cooling starts at the downstream side of the bean immediately at the annular orifice, the cooling effect starting there and existing all the way up the flow stream. The earth heat helps to compensate for the cooling but does not entirely nullify it.

181 I wish to read some more testimony from the deposition, Your Honor, at page 33, and it is the last question on that page:

"Question: Well, you say, in paragraph 3 of the patent, Plaintiff's Exhibit A"—and I wish to call Your Honor's attention to this, that this is still cross examination—

"You say, in paragraph 3 of the patent, Plaintiff's Exhibit A, 'suitable means at the top of the well for easily and accurately regulating the bean in such manner that its area of opening can be noted at the surface at all times.' Well now, do you now say that that was too optimistic a statement to make?

"Answer: I am afraid it was, from our actual experience. We didn't take into consideration this cooling effect that would change the length of that flow stream.

"Question: Well, what happens when the valve is opened too much; I mean by that the lower valve, the bean valve, as you would call it, what happens, what is the bad effect then which becomes apparent?

"Answer: Well, the bad effect is that it opens the orifice out too much or too large an amount, and which allows the well to flow at an excessive rate, which very often the gas-oil ratio increases because of this greater rate.

"Question: Does that become apparent at the top?

"Answer: Yes, sir, it does.

182 "Question: Tell me this, then, why isn't it easy, when that effect becomes apparent, to take a partial turn on this sleeve 13, this right left-hand sleeve 13, and thereby close the valve somewhat at the bottom?

"Answer: Yes, we did that, and as you close it to compensate for that shrinkage, then the temperature changes again, because of the higher temperature, and then it closes more than we anticipated, and then it perhaps would shut off entirely because of the heating action.

"Question: Isn't that just a matter of skill of the operator?

"Answer: Well, yes, but it, it is very difficult to keep changing that back and forth and getting a proper regulation, because of these variables such as this temperature change, and actually the gas-oil ratio of the well will change sometimes due to natural causes, which would change our size of the orifice."

Now turning Your Honor, to the redirect examination portion of the testimony, at page 37 at the top of the page:

"*Redirect Examination*

"BY MR. SIMMS:

"Question: Mr. Knowlton, at the time that the Phillips Petroleum Company, under your supervision, that is, you as an employee supervising the installation in the Yates field and the Oklahoma City field, that we have just
183 discussed, was there a problem confronting the Phillips Company in their production, of reducing

the pressure in a gas well, as distinguished from an oil well, or one that produces both oil and gas, in order to prevent the formation of hydrates of the ground surface?

"Answer: Yes, the common term of freezing of gas wells due to expansion of the gas at the surface, has always been a problem in the industry.

"Question: Has it to the Phillips Company?

"Answer: Yes, sir.

"Question: Was it to you, occupying the position that you did with the company? Do you recall what your position at that time was?

"Answer: I was Chief Engineer at that time.

"Question: Was that a problem that confronted you as Chief Engineer?

"Answer: Yes, sir, it was. Although, of course, I was in charge of production, we had a separate gas department. Although we handled the wells and we drilled the wells for our gas department and handled the operations, of course, the other department was more or less responsible for the marketing of gas, and so forth.

"Question: The marketing, but how about the production?

"Answer: Well, we handled the operation of all the wells and produced them, yes, sir.

184 "Question: If the well tended to freeze to the extent to be a detriment, why, you knew about it, did you?

"Answer: Yes, sir, I was in charge of the operation of the wells.

"Question: It was your job to try to overcome that freezing?

"Answer: Yes, sir, it was.

"Question: And you did have more than one well that did freeze on you?

"Answer: Oh, yes, with all of them, with many of the gas wells, we have that difficulty.

"Question: But you never tried these installations in a gas well?

"Answer: No, sir, we didn't."

Now, we skip part of the testimony, Your Honor, and go over to page 40, about the middle of the page there, the third question.

Do you find it?

THE COURT: Yes.

MR. BROWNING: Yes, sir.

MR. SIMMS: "Question: In considering a gas well, if those were installed, your equipment such as was installed in the Yates and Oklahoma City wells, if they were installed in a gas well and you had too high an opening of the orifice, that is, the orifice was set to open too 185 large, what would be the effect?

"Answer: Do you mean the orifice in the bottom of the hole?

"Question: Yes, sir, in the bottom of the hole?

"Answer: Well, you would have, you would have a cooling, excessive cooling effect.

"Question: Where?

"Answer: At the bottom, just on the downstream side of the orifice, and you would also have a cutting effect, if there was any floating sand present.

"Question: What would happen to the pressure within the tubing between the surface choke and the bottom hole orifice?

"Answer: The pressure would reduce in going up the tubing, depending upon the weight of the column of gas or fluid in the well.

"Question: Well now, here is what I had in mind. In producing the wells, a gas well, as I understand it, they have a surface choke and a bottom hole choke; they will turn the surface choke to provide an opening which will give a certain flow velocity, and it is necessary then to maintain the bottom hole choke orifice size at such an opening as will provide substantially the same flow past that choke as you have at the surface choke?

"Answer: That's desirable to do that. Not all 186 wells are produced that way.

"Question: If the bottom hole choke orifice was greater, the opening was greater than the surface choke, wouldn't that tubing tend to build up a pressure in time?

"Answer: Well, yes, it would.

"Question: So that the pressure differential across the surface choke would increase?

"Answer: That's correct, that is what would happen.

"Question: In time that would happen to the extent that it would possibly cause freezing at the surface, is that right?

"Answer: Well yes, on the downstream side of the surface choke.

"Question: Of the surface choke?

"Answer: If you had a differential of pressure great enough, then when you produced from that surface choke, you would have freezing on the downstream side of the choke. That's what occurs in these wells.

"Question: Yes, sir. In order for your device as shown in the patent, in accordance with your installation that you have described, to work in a gas well to eliminate freezing at the surface choke, that is, the downstream side of the surface choke, you would then have to maintain the bottom hole orifice size at some predetermined ratio to the surface choke orifice size?

187 "Answer: Yes; yes, you would have to do that.

"Question: If the bottom hole orifice size varied from that, to increase, as I understand it, your pressure would build up too great in your tubing and possibly you would obtain freezing, is that correct?

"Answer: That's correct; you will have to regulate the surface choke and the bottom hole choke to take care of it.

"Question: If it was too small, you would get a reduction of your—if your bottom hole orifice is too small, would you get a pressure reduction in time in the tubing between the two chokes?

"Answer: Well, you would have a less pressure there, yes. That would depend upon the opening that you had in your surface choke, however, as to how you regulated that, you see.

"Question: And in your installations that you made in the Yates field and the Oklahoma City field, could you manipulate the surface choke and by that means get the desired manipulation of the orifice size of the bottom hole choke?

"Answer: Well, not, not automatically, you couldn't.

"Question: The orifice size was controlled strictly by the raising and lowering of the tubing?

"Answer: Yes, sir, that's the only way we had to do it, the manual operation of it.

188 "Question: In the conducting of the test in the Yates field, did you employ skilled men for the purpose of making the installation and operating it, did the Phillips Company employ skilled men?

"Answer: Well, we had, we thought we had, at least, skilled men in all of our operations. In other words, we didn't, we didn't employ any special men to operate this. We had our, we used our regular farm boss and our engineer that was in charge, the district engineer, as far as observing this, and Mr. Crites and myself were present there, but as far as the installation goes, our usual crews of men that we employed in West Texas there installed the apparatus under our instructions.

"Question: They do that kind of work every day, do they?

"Answer: Well then, they are skilled men in all kinds of field operations."

That concludes that portion we wish to call directly to Your Honor's attention.

THE COURT: Have you filed this?

MR. SIMMS: It is part of the deposition. The copy is attached to it.

I thought that would be sufficient. It is my understanding that this deposition was received in evidence at the commencement of reading it.

THE COURT: It will be received in evidence.

189 (Thereupon the document was received in evidence and marked Plaintiff's Exhibit No. 7.)

MR. BROWNING: The plaintiff rests, Your Honor.

MR. REYNOLDS: We would like to offer in evidence the defendant's references, and the decisions of the examiner and of the Board of Appeals.

THE COURT: They may be received.

(Thereupon a document was received in evidence and marked Defendant's Exhibit No. 1.)

MR. REYNOLDS: Now, the new Commissioner of Patents took office last Friday, and we have an order here substituting him as the defendant in this case, which we have both consented to.

That is all the evidence we have, Your Honor.

## DEFENDANTS' EXHIBIT NO. 1

UNITED STATES PATENT OFFICE
In re application of:
Herbert C. Otis et al
Serial No.: 473,838
Filed: Jan. 28, 1943
For: WELL FLOW REGULATING APPARATUS
BEFORE THE BOARD OF APPEALS
ON APPEAL

### *Examiner's Statement*

This is an appeal from the final rejection of claims 36-66 inclusive, all the claims now in the case. The amendment received August 12, 1946 has been entered in the case.

The claims on appeal are:

*Claim 36:* In a fluid pressure regulator for the fluids of a flowing well having tubing therein, the combination with a surface control for regulating the rate of withdrawal of well fluids from the tubing, of a body provided with means for mounting it in a well tubing upstream of the surface control and having a flow passage therethrough, valve members in the body for controlling the flow of well fluid through the passage of said body at a predetermined substantially constant pressure reduction, one of said valve members being movable toward and from the other valve member, and means constantly urging said movable valve member toward the other valve member to automatically regulate the flow past the valve members in response to adjustments of the surface control to create and to maintain said predetermined substantially constant reduction in the pressure of the fluid flowing past said valve members.

*Claim 37.* A well fluid pressure regulator as set forth in claim 36, wherein the means for mounting the regulator in a well tubing is insertable and retractable from the top of the well so that the regulator may be lowered into the tubing and removed therefrom.

*Claim 38.* A well fluid pressure regulator as set forth in claim 36, wherein the other valve member is also movable and is held normally stationary by means yieldably restraining its movement, said valve member being movable by a downward fluid pressure of fluid in the well tubing to permit a reverse flow of fluid through the regulator.

*Claim 39.* Means for controlling the flow of a well when the rate of withdrawal and/or the pressure of the fluid discharged from the well is varied which includes, means at the top of the well for controlling the rate of withdrawal of fluid from the well, and flow regulating means in the well below the upper end thereof cooperating with the controlling means at the top of the well, said regulating means including valve elements, one of which is movable with relation to the other valve element and responsive to fluid pressure differences above and below said elements to control the flow of well fluids past said regulating means, said flow regulating means also including a resilient member acting upon the movable valve element to automatically adjust said valve element to regulate the flow and to create and maintain a predetermined substantially constant pressure reduction in the fluid flowing past the flow regulating means when the control means at the top of the well is operated to vary the rate of withdrawal of well fluid.

*Claim 40.* A well fluid flow regulator including, a tubular body adapted to be located in a well and having a flow passage therethrough, a valve seat element in the body having a flow passage communicating with the flow passage of the body, a valve flow restricting element in the body acting with the seat element to regulate flow upwardly of the well fluid through the body, one of the valve elements being movable toward and from the other valve element and having uncovered opposite areas exposed to direct contact with the well fluid flowing through the passage of said body, whereby fluid pressures below and above said movable valve element are directly exerted thereon, and means acting on the movable valve element to resist movement of said element to create a pedetermined flowing pressure differential thereacross, said resisting means acting to automatically adjust the movable valve element to regulate flow through the valve seat to maintain a substantially predetermined pressure reduction across the valve elements when the rate of withdrawal of well fluid flowing through the body is varied.

*Claim 41.* A well fluid flow regulator including, a tubular body adapted to be located in a well and having a flow passage therethrough, a valve seat element in the body having a flow passage therethrough, a valve element disposed in the body to act with the seat element to regulate the flow of well fluid through the passage thereof, one of said valve elements being movable and having upwardly and downwardly facing areas exposed to direct upward and downward pressure exertion of the fluid flowing past said elements, and resilient means acting on the movable valve element to urge said movable valve element toward the other valve element to automatically regulate flow of well fluid through the passage of the seat element to create and maintain substantially a fixed predetermined pressure reduction across said valve elements when the rate of withdrawal of well fluid flowing through the body is varied.

*Claim 42.* A subsurface well fluid flow regulator including, a body adapted to be located in a well and having a flow passage therethrough, valve elements carried by the body, one of said elements being movable with relation to the other element for controlling flow of well fluid through the body and the other valve element being held normally stationary, said movable valve element having a flow passage therethrough communicating with the flow passage of the body and being exposed at each end to the pressures of the fluid flowing through the body, and means acting on the movable valve element to resist movement of said element with respect to the normally stationary valve element to regulate flow through the body to create and maintain a substantially constant predetermined pressure reduction across said body regardless of variations in flow through said passage.

*Claim 43.* A fluid pressure regulator for wells adapted to be mounted in a well pressure fluid conductor and including, a body connected in the conductor and having a flow passage through which the pressure fluid is conducted, flow control valve means within the passage exposed on opposite ends to the fluid pressures on the upstream and downstream side of said means so as to be actuated by the differential in such pressures, and mechanical means acting upon the flow control valve means resisting movement thereof to create and maintain a substantially constant predetermined fluid pressure differential across said valve means irrespective of variations in the flow of fluid past the valve means and through the passage.

*Claim 44.* In a well flow regulating device, the combination of an adjustable anchoring device provided with a well fluid passage therethrough and having anchoring means and external packing for directing flow of well fluids through the flow passage, and a well fluid flow regulator carried by the anchoring device and having a well fluid flow passage communicating with the flow passage of said anchoring device and also having valve means responsive to differences in fluid pressures in the flow passage on the upstream and downstream sides of said regulator for automatically creating and maintaining a predetermined substantially constant reduction in pressure of the fluid flowing past said regulator during variations in such flow.

*Claim 45.* A fluid pressure regulator for well fluids flowing in a well including, a tubular body adapted to be mounted in a well and having a flow passage through which the well fluid flows and having means for mounting it in a well, a valve member mounted within the body, a tubular valve sleeve slidable within the passage and movable with relation to the valve member and adapted to engage said member to close the passage, said sleeve having its opposite ends exposed to the well pressure fluid and responsive to the pressure fluid acting on its opposite ends, and means for resisting opening movement of said sleeve until a predetermined pressure differential occurs thereacross and thereafter co-acting with said sleeve when said sleeve is opened, whereby a predetermined minimum pressure drop across the assembly may be maintained during flow.

*Claim 46.* A pressure regulator for wells including, a tubular body having means for anchoring it in a well tubing and having an axial bore, a stationary valve member mounted within the body, a valve sleeve having a flow passage extending therethrough mounted within the bore of the body and movable with relation to the valve member, the upper end of the sleeve being exposed to the fluid pressure within the tubing thereabove and its lower end exposed to the fluid pressure within the tubing therebelow, and resilient means for urging said valve sleeve toward the stationary valve member to regulate fluid flow through the body and to create and maintain a substantially constant predetermined pressure differential across said sleeve.

*Claim 47.* A pressure regulator for wells including, a tubular body having means for anchoring it in a well tubing and having an axial bore, a stationary valve member mounted within the body, a valve sleeve having a flow passage extending therethrough mounted within the bore of the body and movable with relation to the stationary valve member, means for packing off between the valve sleeve and the bore of the body to direct fluid flow through the sleeve and to cause fluid pressures above and below said sleeve to act against opposing areas thereof, and resilient means for urging the valve sleeve toward the stationary valve member to restrict flow through the sleeve to create and maintain a substantially constant predetermined reduction in the pressure of the fluid flowing through said sleeve.

*Claim 48.* A pressure regulator for wells including, a tubular body having means for anchoring it in a well tubing and having an axial bore, a stationary valve member mounted within the body, a valve sleeve having a flow passage extending therethrough mounted within the bore of the body and movable with relation to the valve member, means for packing off between the valve sleeve and the bore of the body to direct fluid flow through the passage of the sleeve and to cause the fluid pressures above and below said sleeve to act against the opposing areas thereof, a coiled spring surrounding the sleeve and confined within the body for urging said sleeve toward the stationary valve member to restrict flow through the sleeve to create and maintain a substantially constant predetermined reduction in pressure of fluid flowing through the sleeve, and means removably mounted within the device for adjusting the compression of said spring to vary the pressure reduction created across the sleeve.

*Claim 49.* A well fluid regulator for a flowing well including, a body having a well fluid inlet and a flow passage upwardly therethrough from the inlet, valve members in the passage of the body for controlling upward flow of well fluid through said passage one of said valve members being movable toward and from the other valve member and having opposite ends exposed to fluid pressures acting upwardly and downwardly, and resistive means urging the movable valve member toward the other valve member to create and maintain a predetermined substantially constant pressure difference across said members and to cause the movable valve member to automatically respond to the pressure difference across the valve members to regulate the flow through the body between said valve members.

*Claim 50.* A well fluid flow regulator adapted to be mounted in a well including, a tubular body having means for securing it in a well tubing below the surface of the well and provided with a flow passage therethrough, a valve member mounted within the body, means holding said valve member normally stationary in said body, a tubular valve sleeve slidable within the passage of the body and movable with relation to the valve member, the sleeve having its upper end exposed to fluid pressure thereabove and its lower end exposed to fluid pressure therebelow, and means yieldably urging said sleeve toward the valve member to regulate flow through the body to create and maintain a substantially constant predetermined pressure differential across the sleeve, said normally stationary valve member being movable away from the sleeve to permit a downward flow therethrough.

*Claim 51.* A pressure regulator including, a tubular body having means for anchoring it in a well and having an axial bore with a port in the body establishing communication between said bore and the exterior of the body, a spring loaded valve member mounted within the body normally urged to and held in a predetermined position, a valve sleeve slidably mounted in the bore of the body above the valve member and movable with relation to said member, the sleeve having its upper end exposed to the fluid pressure thereabove and its lower end exposed to the fluid pressure therebelow, resilient means urging said sleeve toward the valve member, and stop means limiting the movement of the sleeve toward the valve member, the yieldable mounting of the valve member permitting movement of said member away from the sleeve by a pressure from above to allow fluid to flow downwardly through the bore of the body and outwardly through the port.

*Claim 52.* A pressure regulator including, a tubular body adapted to be anchored in a well tubing and having an axial bore with a lateral port in the body establishing communication between said bore and the exterior of the body, a spring loaded valve member movably mounted in the body adjacent the lateral port and normally urged to and held in a predetermined stationary position, a valve sleeve slidably mounted in the bore of the body above the valve member and movable with relation to said member, means for limiting downward movement of the valve sleeve so that the lower end of said sleeve is constantly exposed to the upstream fluid pressure, the upper end of the sleeve being exposed to the downstream fluid pressure within the tubing above the said sleeve, and means constantly urging said sleeve toward the valve member to regulate flow of fluid through the bore of the body to create and maintain a substantially constant pressure reduction in the fluid flowing through the body, the yieldable mounting of the valve member permitting downward movement of said member by fluid pressure from above to allow a downward flow of fluid through the body.

*Claim 53.* A well fluid regulator including, a body having a well fluid inlet and a flow passage upwardly therethrough from the inlet, means for securing the body in a well tubing, a first valve member movable in the body, means holding said member normally stationary in said body, a second valve member in the body movable toward and from the normally stationary first valve member, and yieldable means urging the second valve member toward the first valve member set to resist movement of the second valve member from the first valve member to create a predetermined pressure differential across the second valve member and to automatically adjust said second valve member to regulate upward flow between the valve members to maintain said pressure differential substantially constant during variations in flow.

*Claim 54.* A well fluid flow regulator as set forth in claim 53, with means for arresting movement of the second valve member toward the first valve member to permit independent movement of the first valve member away from the second valve member.

*Claim 55.* A well fluid flow regulator including, a body having a fluid flow passage therethrough and provided with means for mounting it in a well tubing, spring pressed valve members movable with relation to each other, one of said valve members being held normally stationary, the other valve member having its opposite ends constantly exposed to fluid pressures above and below it and set to respond to the difference in fluid pressures above and below it to move toward and from the normally stationary valve member to regulate flow through the body to create and maintain a substantially constant reduction in the pressure of fluid flowing through said body.

*Claim 56.* In an automatic flow pressure regulator for the eduction tubing of a well, the combination with a surface control for regulating the withdrawal of the well fluids from the tubing, of a body adapted to be inserted in the tubing upstream of the surface control and having means for mounting it in such tubing, the body also having a well fluid flow passage adapted to conduct well fluids therethrough, and valve means in the body exposed to upstream and downstream fluid pressures and set to automatically yield to differences in such pressures of the well fluid flowing past said valve means to regulate the flow of such fluid through the passage of the body to automatically create and maintain a predetermined pressure reduction across said valve means during variations in withdrawal of well fluid responsive to flow regulating adjustments of the surface control.

*Claim 57.* Means for varying the withdrawal of well fluids from the eduction tubing of oil and gas wells which includes, a surface control having an adjustable withdrawal outlet and connected with the upper end of the tubing, valve means in the well upstream of the surface control and automatically movable in response to fluid pressure differentials thereacross to maintain a predetermined pressure reduction in the well fluid flowing past said valve means, and resilient means set to regulate movement of the valve means in response to variations in the rate of withdrawal through the surface control to maintain substantially constant the predetermined pressure reduction in well fluids flowing through the valve means.

*Claim 58.* Means for varying the rate of withdrawal of well fluids from the eduction tubing of oil and gas wells which includes, a surface control having an adjustable withdrawal outlet and connected with the upper end of the tubing, and valve means in the tubing upstream of the surface control and having a spring loaded element responsive to fluid pressures on its upstream and downstream sides and automatically movable to create and maintain a predetermined pressure reduction in the well fluids flowing past said valve means in response to variations in the rate of withdrawal of well fluids through the surface control.

*Claim 59.* Means for controlling the flow of fluids from a well including, a surface control for varying the withdrawal of well fluids from the well, and regulating means in the well flow stream spaced upstream from said surface control and including valve members, one member being movable with respect to the other member and exposed to differences in fluid pressures on its upstream and downstream sides, and pressure exerting means urging said movable valve member toward the other valve member to automatically regulate flow past said members to create and maintain a substantially constant predetermined reduction in the pressure of the fluids flowing past said regulating means during variations in withdrawal of well fluids as controlled by the surface control.

*Claim 60.* Means for controlling the flow of fluids from a well having an inlet and an outlet including, valve means for controlling withdrawal of fluid from the well outlet, and regulating means responsive to differences in fluid pressures on its upstream and downstream sides disposed between the well inlet and said valve means for automatically creating and maintaining a predetermined substantially constant reduction in pressure of the fluid flowing past said regulating means during variations in withdrawal of fluid from the well as controlled by said valve means.

*Claim 61.* Means for controlling the flow of fluids from a well including, valve means at the well surface for controlling the flow of fluid from the well, and a plurality of spaced pressure responsive means disposed upstream of the valve means for automatically maintaining a predetermined reduction in pressure of the fluid flowing therepast to said valve means.

*Claim 62.* Means for controlling the flow of fluids from a well including, valve means at the well surface for controlling the flow of fluid from the well, and a plurality of spaced pressure responsive means disposed upstream of the valve means for automatically maintaining a predetermined reduction in pressure of the fluid flowing therepast to said valve means, said spaced pressure responsive means being set to each maintain a substantially constant portion of the predetermined pressure reduction on the flowing fluid.

*Claim 63.* A pressure regulator for wells including, a tubular body adapted to be located in a well tubing and having an axial bore, a valve member movably mounted within the body and normally held stationary therein, a valve sleeve having a flow passage extending therethrough mounted within the bore of the body and movable with relation to the normally stationary valve member, means for packing off between the valve sleeve and the bore of the body to direct the fluid flow through the sleeve and to cause fluid pressures above and below said sleeve to act against opposing areas thereof, and resilient means for urging the valve sleeve toward the normally stationary valve member to restrict flow through the sleeve to create and maintain a substantially constant predetermined reduction in the pressure of the fluid flowing through said sleeve.

*Claim 64.* A pressure regulator for wells including, a tubular body adapted to be located in a well tubing and having an axial bore, a valve member movably mounted within the body and normally held stationary therein, a valve sleeve having a flow passage extending therethrough mounted within the bore of the body and movable with relation to the normally stationary valve member, means for packing off between the valve sleeve and the bore of the body to direct fluid flow through the passage of the sleeve and to cause the fluid pressures above and below said sleeve to act against opposing areas thereof, a coiled spring surrounding the sleeve and confined within the body for urging said sleeve toward the normally stationary valve member to restrict flow through the sleeve to create and maintain a substantially constant predetermined reduction in pressure of fluid flowing through the sleeve and means movably mounted within the body for adjusting the compression of said spring to vary the pressure reduction created across the sleeve.

*Claim 65.* A well fluid flow apparatus including, a well flow tubing, a device connected in the tubing having a valve seat and a flow member movable toward and from said seat to shut off flow through the tubing and to permit flow through said tubing, said member having substantially equal effective areas at each end exposed to the well fluid pressures thereabove and therebelow, fluid-pressure responsive means responsive to pressure differentials above and below said member when said member is moved away from its seat for automatically adjusting said member in accordance with the rate of flow through the device to maintain a fixed pressure drop thereacross regardless of variations in the rate of such flow, and means connected in the tubing beyond the device adjustable for controlling the rate of withdrawal of well fluid through the tubing and said device, the device being automatically responsive to adjustments of said means.

*Claim 66.* The system of controlling the flow of high pressure wells therein the flowing well fluid contains gas which includes, a flow tubing having a portion disposed in the well, a control device connected in the tubing and having means adjustable to regulate the rate of withdrawal of well fluid from the tubing, and a valve device connected in the tubing between the producing formation and the control device including a valve seat and a valve member movable to and from said seat in the path of the flowing fluid, and means for urging the valve member toward the seat responsive to fluid pressure differentials across the valve device, whereby variable flow restrictive areas between said member and its seat are set up, the movable valve member being automatically responsive to adjustments of the control device and variations in the pressure of the fluid flowing from the formation to set up a restrictive flow area in accordance with adjustments of said control device and variations in the formation flowing pressure to maintain a substantially fixed pressure drop across the valve device irrespective of variations in the rate of withdrawal of well fluid from the tubing.

References relied on:

| | | |
|---|---|---|
| Knowlton et al | 1,905,592 | April 25, 1933 |
| Otis | 1,920,103 | July 25, 1933 |
| Bruce | 1,199,152 | Sept. 26, 1916 |
| Nichols | 1,637,085 | July 26, 1927 |
| Otis | 1,972,791 | Sept. 4, 1934 |

The invention relates to improvements in devices for regulating productive fluid flow in high pressure oil wells, particularly where the gas-to-oil ratio is high or the fluid produced is substantially all gas, the fluid flow taking place through the conventional well tubing, which is a pipe of considerably less diameter than the surrounding well casing and usually extends downwardly from the top of the well to the vicinity of the productive portion of the well.

The invention consists of improvements in fluid flow regulating devices arranged to be positioned and anchored within the well tubing, and also in the combination of one or more of such fluid flow regulating devices with an adjustable surface control device connected to the upper end of the well tubing to control the rate of withdrawal of well fluid from the well. When using more than one of the fluid flow regulating devices within the well tubing, the devices are spaced from one another. Applicants' flow regulator is a variable choke including a valve structure arranged to normally close the flow passage through the choke at low pressures. The aforesaid regulator, two modifications of which are illustrated and claimed in this case, consists generally of a tubular body in which the variable choke and valve structure is housed, and a tubular mandrel connected to the upper end of the tubular body. Said mandrel carries packings to seal between the regulator and the well tubing and gripping slips to wedge between the regulator and tubing to anchor the regulator at any desired position within the tubing.

Both modifications of the regulator have in common a tubular valve sleeve slidably mounted within the tubular body. The valve sleeve has a beveled valve seat on its lower inner wall arranged to seat upon an upwardly projecting lower valve pin or element mounted in the lower end of the tubular body, closing the passage through the sleeve valve. As there is a packing between the valve sleeve and the regulator body all fluid passing through the regulator must pass through the valve sleeve. A coil spring surrounding the valve sleeve urges it downwardly against the lower valve element. In the first modification this lower valve element is fixedly mounted in the body and in the second modification it is slidably mounted in the body, being urged to an uppermost position by a coil spring where it will normally engage the valve sleeve. A flange engages the lower valve element of the second modification when the valve is in uppermost position to prevent further upward movement of the valve. Fluid under pressure, entering the regulator body below the valve sleeves, will, at predetermined pressure, raise the valve sleeve to permit fluid to flow through the regulator and upwardly through the well tubing to surface. When using the second modification, fluid may be directed downwardly within the well tubing through the valve sleeve in the regulator and at predetermined pressure will unseat the lower valve element which is urged upwardly into closed position by a coil spring and discharge into the well.

Otis 1,972,791 has been cited in this statement as applicants make reference to said patent on page 9 of the specification.

Claims 36-39, inclusive, 56-62 inclusive, 65 and 66 were rejected for lack of patentability in the alleged combination according to In re McNeil 1902 C. D. 563 in view of Knowlton et al 1,905,592. It is thought that the patent to Knowlton et al teaches the combination of a surface control with a fluid flow regulating structure in the conventional well tubing below the surface control. It appears that what applicants have done is to substitute an automatically or fluid pressure operable flow regulating structure for the manually operable flow regulating structure shown in Knowlton et al, and it is thought that this is the mere carrying forward of the original thought and is a change only in form, proportions, or degree; doing the same thing in the same way by substantially the same means, probably with better results, but is not such an invention as will sustain a patent. The type of valve employed by applicants in their flow regulating structure is considered old in the art as shown in Bruce and Nichols. Claims 36-39 inclusive, 56-62 inclusive, 65 and 66 were also rejected on Knowlton et al 1,905,592 in view of Bruce or Nichols, each of which latter patents discloses an automatically or fluid pressure operated valve structure which may be substituted for the bottom hole choke in Knowlton et al.

Claims 40-43 inclusive, 45, 49 and 50 were rejected as clearly readable on Bruce or Nichols. It is thought that the claims recite the valve structure shown in the patents.

Claims 44, 46-48 inclusive, 51-55 inclusive, 63 and 64 were rejected on Nichols in view of Otis 1,920,103. It is thought that it would be devoid of invention to use the housing or tubular body of Otis, with its packing and pipe gripping slips mounted on the outside of the body, and modify the Otis structure by mounting the valve structure of Nichols on the inside of the Otis body, in place of the ball valve and choke of Otis.

Claims 46-48 inclusive were rejected on Bruce in view of Otis 1,920,103. It is thought that it would not be invention to substitute the valve structure of Bruce for the valve and choke structure within the housing of the Otis device.

Respectfully submitted,
/s/ Karl R. Lesh
Examiner

* * * *

# IN THE UNITED STATES PATENT OFFICE

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## BEFORE THE BOARD OF APPEALS

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*Ex parte* Herbert C. Otis
and John C. Luccous

---

Application for Patent filed January 28, 1943, Serial No. 473,838. Well Flow Regulating Apparatuses.

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Messrs. Jack A. Schley & Joseph H. Schley for applicants.

---

This is an appeal from the final rejection of claims 36 thru 66, all the claims remaining in the case.

The request that the appeal as to claims 37, 42, 43, 45, 47, 58, 63 and 64 be dismissed has been noted.

The following claims are representative:

36. In a fluid pressure regulator for the fluids of a flowing well having tubing therein, the combination with a surface control for regulating the rate of withdrawal of well fluids from the tubing, of a body provided with means for mounting it in a well tubing upstream of the surface control and having a flow passage therethrough, valve members in the body for controlling the flow of well fluid through the passage of said body at a predetermined substantially constant pressure reduction, one of said valve members being movable toward and from the other valve member, and means constantly urging said movable valve member toward the other valve member to automatically regulate the flow past the valve members in response to adjustments of the surface control to create and to maintain said predetermined substantially constant reduction in the pressure of the fluid flowing past said valve members.

40. A well fluid flow regulator including, a tubular body adapted to be located in a well and having a flow passage

therethrough, a valve seat element in the body having a flow passage communicating with the flow passage of the body, a valve flow restricting element in the body acting with the seat element to regulate flow upwardly of the well fluid through the body, one of the valve elements being movable toward and from the other valve element and having uncovered opposite areas exposed to direct contact with the well fluid flowing through the passage of said body, whereby fluid pressures below and above said movable valve element are directly exerted thereon, and means acting on the movable valve element to resist movement of said element to create a predetermined flowing pressure differential thereacross, said resisting means acting to automatically adjust the movable valve element to regulate flow through the valve seat to maintain a substantially predetermined pressure reduction across the valve elements when the rate of withdrawal of well fluid flowing through the body is varied.

46. A pressure regulator for wells including, a tubular body having means for anchoring it in a well tubing and having an axial bore, a stationary valve member mounted within the body, a valve sleeve having a flow passage extending therethrough mounted within the bore of the body and movable with relation to the valve member, the upper end of the sleeve being exposed to the fluid pressure within the tubing thereabove and its lower end exposed to the fluid pressure within the tubing therebelow, and resilient means for urging said valve sleeve toward the stationary valve member to regulate fluid flow through the body and to create and maintain a substantially constant predetermined pressure differential across said sleeve.

The references relied upon are:

| | | |
|---|---|---|
| Bruce | 1,199,152 | Sept. 26, 1916 |
| Nichols | 1,637,085 | July 26, 1927 |
| Knowlton et al | 1,905,592 | Apr. 25, 1933 |
| Otis | 1,920,103 | July 25, 1933 |
| Otis | 1,972,791 | Sept. 4, 1934 |

The subject matter of the appealed claims relates to a fluid pressure regulating device adapted to be associated with well casings and tubings to regulate and/or control the productive fluids of oil or gas wells. The device is described in detail in both the Examiner's Statement and appellants' brief.

All the claims have been rejected as unpatentable over the prior art.

Claims 36, 38, 39, 56, 57, 59 thru 62, 65 and 66 stand rejected as being unpatentable over Knowlton et al (No. 1,905,592) on the ground that they are directed to an old combination. Claims 36, 38, 39, 56, 57, 59 thru 62, 65 and 66 stand further rejected as being unpatentable over Knowlton et al, (No. 1,905,592) in view of Bruce or Nichols. Claims 40, 41, 49 and 50 stand rejected as clearly reading on the patent to Bruce or Nichols. Claims 44, 46, 48, and 51 thru 55, stand rejected as unpatentable over Nichols in view of Otis (No. 1,920,103) and claims 46 and 48 stand further rejected as being unpatentable over Bruce in view of Otis (No. 1,920,103).

The Knowlton et al Patent No. 1,905,592 discloses the combination of a surface choke and a bottom hole choke which is manually adjusted up and down thru the tubing by means of rotating nut 33.

The Otis Patent No. 1,920,103 discloses a bottom hole choke in well tubing comprising a valve bushing 50 beveled at its lower end to provide a seat for the ball valve 55 and positioned in the tubing by an expanding mandrel provided with means for sealing the same in the well tubing.

The Bruce patent shows an automatic flow regulating valve in an engine manifold including a tubular body having an axial bore, a stationary valve member mounted within the body, a valve-sleeve having a flow passage extending therethru mounted within the bore of the body and movable with relation to the valve member, both the upper and lower end of the valve sleeve being exposed to the fluid pressure adjacent their surfaces, and resilient means for urging the valve sleeve toward the stationary valve members to regulate the fluid flow thru the body.

The Nichols patent discloses a vibrating pressure regulator for controlling the degree of inflation of pneumatic tires.

Careful consideration has been given to the arguments made before us on behalf of the appellants, both orally and by brief, as well as to the affidavits of record. We cannot agree with the position taken by the Examiner that the Knowlton et al Patent No. 1,905,592 discloses the combination defined by the appellants in claims 36, 38, 39, 56, 57, 59 thru 62, 65 and 66, namely, a surface choke in combination with a bottom hole choke or regulator automatically responsive to the adjustments of the surface choke. However, we do not believe that, in view of the prior art patent to Bruce, it would involve the exercise of the inventive faculties to substitute, for the manually operated valve or bottom hole choke in the Knowlton et al well control device, an automatic valve of the type disclosed by Bruce. We recognize that Bruce does not show his valve used in connection with regulating or controlling the flow of fluid in wells but he does teach the use of an automatic valve, similar to appellants' valve, to automatically regulate the flow of fluid. To us, therefore, it seems to involve nothing more than mechanical skill to adapt the Bruce automatic regulating valve so that it can be substituted for the manually operated Knowlton et al valve in well tubing. To use more than one valve as called for by claims 60 and 61 involves but a question of duplication. We accordingly agree with the Examiner's rejection of claims 36, 39, 56, 57, 59 thru 62, 65 and 66 in Knowlton et al in view of Bruce. As to claim 38, we find that it recites that both valve members are provided with means for yieldingly restraining their movements. Bruce fails to disclose such valve structure. We are therefore constrained to disagree with the Examiner's rejection of this claim.

We cannot agree with the Examiner that the Nichols patent can be used either as a primary or secondary reference in the rejection of any of the claims on appeal. The subject matter disclosed in the said patent is directed to a vibrating pressure regulator which we feel would require more than mechanical skill to adapt it for use in well tubing to regulate and control the flow of fluids.

We agree with the Examiner that the Bruce patent discloses the valve structure recited in claims 40, 41, 49 and 50. The introductory clause in these claims, which indicates that the pressure regulator defined is adapted to be mounted in a well, in our opinion, is not a limitation in any patentable sense upon the structure recited. In re Rockwell 580 O. G. 158; 1945 C. D. 461. Nor do we find that the functional statement in the last clause of claim 50 lends patentability to the structure recited therebefore. In re Wharton, 592 O. G. 416; 1946 C. D. 536.

We also agree with the Examiner that claims 46 and 48 are not patentable over Bruce in view of Otis (1,920,-103). We believe that any one skilled in the art could substitute a valve of the type shown by Bruce for the valve in the Otis well tool. We are further of the opinion that the claims are met by Bruce even without the support of Otis. But for the use of the pressure regulator specified in the preamble of the claims the structure defined is substantially that of the Bruce regulating valve. We are satisfied that the use or purpose of the pressure regulator set forth in the preamble of these claims is not a sufficient basis to justify their allowance over Bruce. In our opinion claim 44 is likewise unpatentable over Bruce in view of Otis (1,920,103), the latter reference disclosing the combination of an adjustable anchoring device and a well choke. The substitution of a Bruce type valve for the valve used in the Otis well tool, as stated above, at the most appears to involve but a question of mechanical skill.

In view of our position taken with respect to the Nichols patent, we find claims 51 thru 55 allowable.

The appeal as to claims 37, 42, 43, 45, 47, 58, 63 and 64 has been dismissed.

The decision of the Examiner is affirmed as to claims 36, 39 thru 41, 44 thru 50, 56, 57, 59 thru 62, 65 and 66 and is reversed as to claims 38 and 51 thru 55.

In the event of appeal attention is directed to In re Boyce, 32 CCPA, 718, 144 Fed. (2d), 896, 1944 C. D., 609, 568 O. G., 568, 63 USPQ 80, in regard to specifically including in the appeal notice *all* grounds of rejection in the Examiner's Statement not expressly overruled by the Board.

Substituted for
Mr. C. H. Shaffer
retired March 31, 1947.

/s/ F. J. Porter
Examiner-in-Chief
/s/ L. P. McCann
Examiner-in-Chief
/s/ Harvey E. Kauffman
Examiner-in-Chief
(Acting)
BOARD OF APPEALS

Messrs. J. A. Schley &
Joseph H. Schley
1302 Tower Petroleum Bldg.
Dallas, Texas
July 23, 1947.

* * * *

### *On Petition for Reconsideration*

This is a petition for reconsideration on the decision of the Board of Appeals dated July 23, 1947.

We have reviewed and carefully reconsidered our decision in view of the contentions made in the petition and find no reasons for making any alterations or amplification except perhaps that it might be emphasized that the patentees, Knowlton et al, were confronted with substantially the same problem that confronts the appellants as is indicated by the paragraph beginning with line 37, column 1, page 1 of their patent.

"A still further object is to provide control means for use with high pressure gas wells where the freezing of surface control equipment is a serious problem. By using an adjustable bottom hole bean made in accordance with the invention, the uniform year-round temperature at the bottom of the hole is taken advantage of and no surface choking is necessary. By such equipment, we can eliminate the expansion of gas at the surface, which usually results in freezing of equipment."

Their solution to the problem is the use of a manually operated bottom hole choke in conjunction with the surface choke whereas the appellants' solution is the use of a bottom hole choke automatically repsonsive to the adjustment of the surface choke. As held by us, we do not regard the substitution of an automatically controlled bottom hole choke for a manually controlled one an act involving the exercise of the inventive faculties in view of the prior art showing.

The proposed amendment to claim 50 has been noted, however, we do not agree with the appellants that such an amendment would lend patentability to the claim and, therefore, we do not make any recommendation to amend this claim.

The petition has been considered but is denied in respect to making any change in our decision.

Substituted for
Mr. C. H. Shaffer
retired March 31, 1947.

/s/ F. J. Porter
Examiner-in-Chief
/s/ L. P. McCann
Examiner-in-Chief
/s/ Harvey E. Kauffman
Examiner-in-Chief
(Acting)
BOARD OF APPEALS

December 8, 1947.
Messrs. Jack A. Schley
and Joseph H. Schley
1302 Tower Petroleum Bldg.,
Dallas, Texas

U. S. Patent Office Aug 14 1945 Rc'd. Div. 32

### *Affidavit*

State of Texas )
)
County of Tarrant )

Before me, the undersigned authority, on this day personally appeared William F. Knode, who, being first duly sworn, deposes and says that he resides at Fort Worth, Tarrant County, and State of Texas.

That he is a registered professional engineer, engaged in the practice of petroleum engineering; that he has been engaged in the practice of petroleum engineering for the past seventeen years; that he is presently engaged in the practice of petroleum enginering as a consulting engineer, located at Fort Worth, in the State of Texas, that he has been familiar with oil field practice for the past thirty-five years and has actually worked with the installing, operation and maintenance of oil field equipment during this period of time.

He further states that he has had actual engineering and practical experience in the oil and gas fields of South Texas since 1934 and during this time, he has had almost constant opportunity to observe the performance of gas wells and knows of his own knowledge that freezing has been a problem of a serious nature in these fields; and that to his actual knowledge, the problem of freezing and efforts to overcome the freezing of gas wells has existed for the past thirty-five years.

He states that from 1938 to 1941 he was Chairman of The Conservation Board of the Province of Alberta, Canada, during which period he was in daily contact with the oil and gas fields. That during this period, he periodically returned to the United States and was in the oil fields on numerous occasions. That in his practice as a consulting engineer, he is called upon to aid in the solution of oil and gas well problems and to recommend equipment for their solution and to aid in the designing of such equipment.

He further states that he has read and examined the application of Herbert C. Otis and John C. Luccous, entitled WELL FLOW REGULATING APPARATUSES, filed January 28, 1943, Serial No. 473,838, and that he fully understands the invention therein set forth; and that he has actually observed the operation in the oil and gas fields of apparatuses made in accordance with the aforesaid invention.

He states that the oil and gas industry has been faced, for the past twenty years or more, with the problem of providing for variable withdrawal of fluids from high pressure wells while maintaining a substantially constant reduction in the pressure of the well during such variations in withdrawal, particularly where the gas-to-oil ratio was high. He states that, within his knowledge, no satisfactory solution of this problem was apparent to him prior to the invention of Otis and Luccous and he does not believe it was apparent to others with whom he was associated. That while adjustable well surface control devices or chokes have been used in connection with adjustable beans or chokes located in the well for the purpose of regulating the rate of withdrawal of the well fluid and for reducing the pressure of the fluid in the well, such devices required not only manual adjustment of the surface device, but also separate manual adjustment of the choke in the well and were not satisfactory.

That, so far as he knows, Otis and Luccous are the first to produce a regulator located in the well which is automatically responsive to various adjustments of the surface control to vary the rate of flow, and at the same time maintaining a substantially fixed pressure reduction across the regulator, regardless of such variations in withdrawal. He further states that in view of the seriousness of the problem, that if there had been other devices capable of performing this automatic result, they would have been used by the industry; and that, in his opinion, based upon his actual experience and knowledge, the Otis-

Luccous invention has provided the solution to the aforesaid problem, and that the Otis-Luccous invention has been widely accepted and put into use by the industry.

He further states that he has carefully examined and read the patent to Knowlton and Crites, No. 1,905,592, issued April 25, 1933 and the patent to Shoff, No. 391,431, issued October 23, 1888; that the aforesaid patents do not and did not suggest to him the Otis-Luccous invention or the automatic result accomplished thereby. That he knows of numerous other devices and patents used in controlling the flow of gas wells, and none of these devices or patents suggested to him the aforesaid result. That it is his opinion that the Shoff patent is not capable of accomplishing the automatic response to variations in the rate of withdrawal in accordance with the Otis-Luccous invention and it does not suggest to him how it might be changed or modified to accomplish the desired result. That he has actually worked with devices similar to the Knowlton and Crites patent and, in view of the fact that such devices require separate manual adjustment of the surface choke and the regulator in the hole, they are not capable of performing the functions of the Otis-Luccous invention and such devices were discarded because of unsatisfactory operation.

That he has read the affidavits of E. O. Bennett and L. T. Potter, and agrees therewith in substance. That he is personally acquainted with, and has known for many years, both Mr. E. O. Bennett and Mr. L. T. Potter, and knows them to be engineers of high standing and well qualified in both oil and gas engineering and practice.

/s/ William F. Knode.

Subscribed and sworn to before me, this 6th day of August, 1945, to certify which, witness my hand and seal of office.

/s/ Cassie Marie Rosser
Cassie Marie Rosser
Notary Public, Tarrant County, Texas

A. S. BRUCE.

AUTOMATIC FLOW REGULATING VALVE.

APPLICATION FILED JAN. 14, 1916.

**1,199,152.** Patented Sept. 26, 1916.

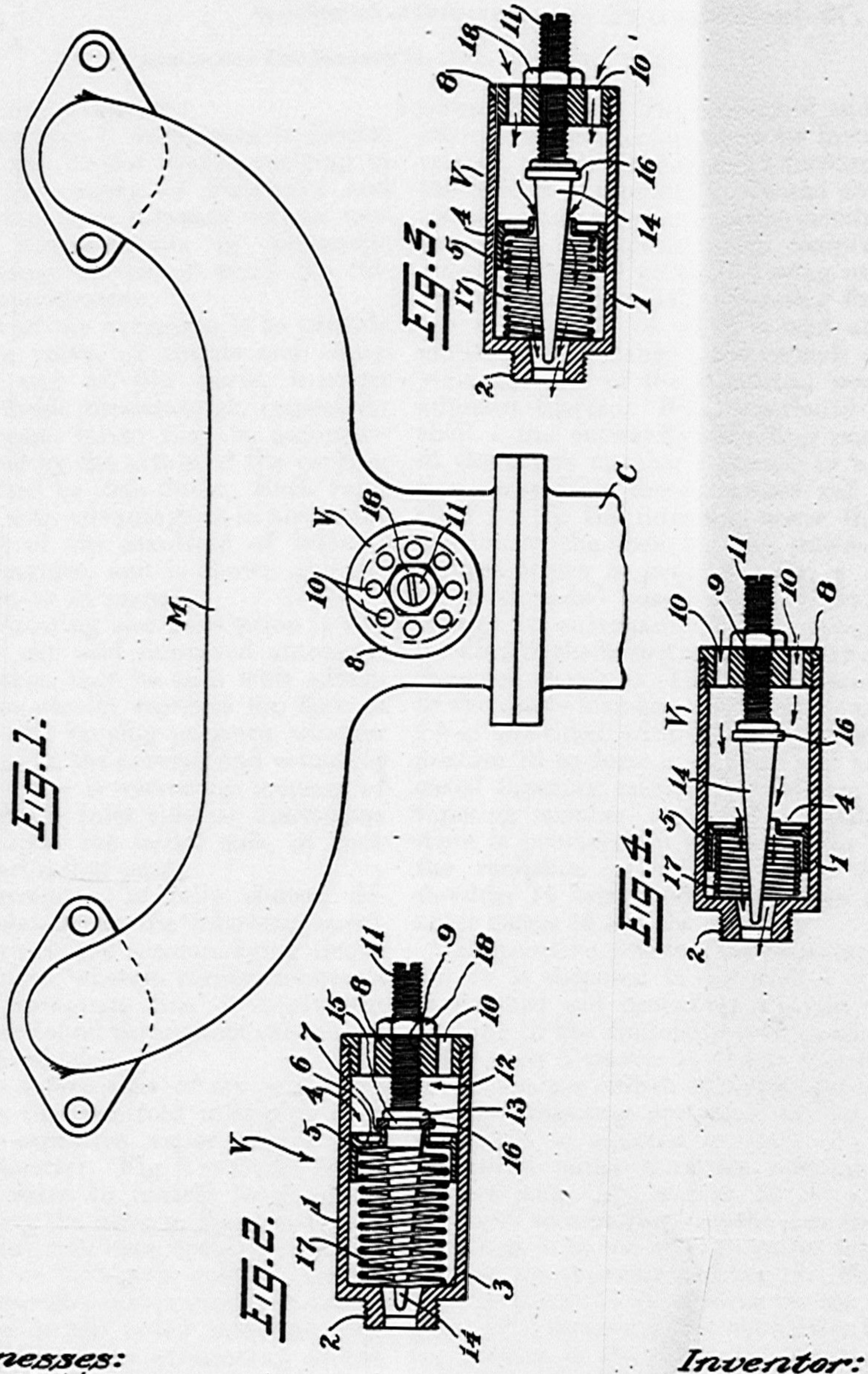


Fig. 3.

Fig. 1.

Fig. 4.

Fig. 2.

Witnesses:
Chas. E. Whiteman
H. D. Penney

Inventor:
Alexander S. Bruce.
By his Atty. F. H. Richards.

# UNITED STATES PATENT OFFICE.

ALEXANDER S. BRUCE, OF BANGOR, MAINE, ASSIGNOR OF ONE-HALF TO JOHN J. LOGAN, OF ALBANY, NEW YORK.

## AUTOMATIC FLOW-REGULATING VALVE.

1,199,152. Specification of Letters Patent. Patented Sept. 26, 1916.

Application filed January 14, 1916. Serial No. 72,027.

*To all whom it may concern:*

Be it known that I, Alexander S. Bruce, a citizen of the United States, residing in Bangor, in the county of Penobscot and State of Maine, have invented certain new and useful Improvements in Automatic Flow-Regulating Valves, of which the following is a specification.

The object of my invention is to provide an automatic valve, of simple and cheap construction and of few parts, whereby the flow of fluids therethrough (especially those of gaseous form) may be automatically regulated by the action of the varying pressure exerted by such fluids. Such valve may be used with advantage as in air-intake for the inlet of the manifold of internal combustion engines, and is shown and described herein as so placed.

From the drawing and description it will be seen, that my said improved automatic regulating valve, may be used with advantage, to automatically regulate the flow of all fluids, by the varying pressure, whether the pressure upon the moving and actuating parts of the valve is varied by increase of pressure upon the inlet side, or diminution of pressure upon the outlet side, of such moving and actuating parts.

My said invention is fully shown, described and claimed in the following specification, of which the accompanying drawing forms a part, wherein similar numerals of reference designate like or equivalent parts wherever found throughout the several views, and in which:—

Figure 1 is a face view of my said valve as applied to the manifold inlet-pipe of a two-cylinder explosive vapor engine just above the carbureter. Fig. 2 is a view in detail of such valve in central longitudinal section, showing the same in the closed position. Fig. 3 is a like view showing the same in the medial or half open position, caused by increased pressure upon the inlet or diminished pressure on the outlet side, and Fig. 4 is a like view of the positioning of the moving parts, when upon further increase of exterior or diminution of interior pressure the valve-disk is forced to the fully open position.

In the embodiment shown the valve comprises an outer shell 1 having a diminished end 2 at one end thereof which is externally screw threaded and the other end internally screw threaded. The diminished end has a conical opening enlarging in its inward direction, the diminished end 2 forming with the shell 1 a shoulder 3. In the shell 1 a reciprocating member or active member 4 of the valve is disposed which comprises an outer cylindrical portion 5 having near one end an inward radially extending flange 6, the inner end 7 of which is bent at right angles to such flange 6 and extends out beyond the end of the cylindrical portion 5 adjacent thereto. When positioned in the shell 1 the outwardly extending portion 7 of the active member 4 extends in a direction away from the diminished end of the shell 1. To the internally screw threaded portion of the shell 1 a disk member 8 is secured which is provided with a central screw threaded bore 9 and a plurality of orifices 10 surrounding such central bore. Secured in the bore 9 of the disk 8 is a screw threaded shank 11 of the guide member 12 of the active member 4. The guide member 12 is provided with an enlarged annular portion 13 to form a shoulder and an elongated tapering member 14, between which tapering member 14 and the shoulder 13 there is provided an annular recess 15, for the reception of a stop-washer 16, the shoulder 14 being disposed between the annular recess 15 and the shank 11.

In operative position, the tapering member 14 is disposed in the shell 1 with its diminished end projecting into the conical opening in the diminished end 2 and is provided with a washer 16 of any suitable material against which the diminished outwardly extending portion 7 of the active member 4 is adapted to abut, the active member 4 being normally maintained in contact with this washer 16 by the coil spring 17 strained between the shoulder 3 and the flange 6 of the active member 4 and encircling the tapering member 14. For locking the shank 11 in position on the disk 8, a nut 18 is secured to the outwardly extending portion of the shank 11. By means of the screw threaded shank 11, its end being slotted, the tapering member 14 may be adjusted to extend a greater or less distance into the conical opening of the diminished portion 2 to change the size of opening therethrough and furthermore to change the tension on the spring 17.

The valve V may be secured to any part

of a fuel conduit of a combustion engine, in the present instance, Fig. 1, the valve being shown as secured to the manifold M of an automobile engine between the carbureter C and the combustion chamber not shown, the external screw threaded portion 2 being secured into an opening provided in the manifold M.

In the operation of the device, it will be seen that according to the vacuum created upon the outlet side of the valve, or an excess of pressure created upon the inlet side, the active member or disk-valve 4 will be drawn a greater or less extent toward the diminished end of 2, against the tension of the spring 17 and thereby, due to the tapering member 14 gradually narrowing as it approaches the diminished portion of the shell 2, the opening between the active member 4 and the tapering member 14 will increase, and thus the air drawn in through the perforations 10, will be more or less freely drawn in therethrough, according to the size of the opening between the active member 4 and the tapering member 14, which is determined by the variation of pressure, and proportioned by the adjustment of the tapering member 14, by means of its positioning.

It is obvious that various changes and modifications may be made to the details of construction without departing from the general spirit of the invention.

I claim:

1. In an automatic flow-regulating valve, a casing having an inlet and an outlet; a tapered-spindle or member adapted by change in position to vary the area of the casing passage; and a bodily moving disk-member or valve with an orifice through which the spindle passes, reciprocated upon the spindle by variations in the pressure, from the fully open to the fully closed position.

2. In an automatic flow-regulating valve, a casing having an inlet and an outlet; a tapered-spindle or member adapted by change in position to vary the area of the casing passage; and a bodily moving disk-member or valve with an orifice through which the spindle passes, reciprocated upon the spindle by variations in the pressure, from the fully open to the fully closed position; and a spring normally forcing the disk-member valve into closure.

3. In an automatic flow-regulating valve, a stationary member; a shoulder on said stationary member having an elongated tapering portion extending therefrom; and an active valve member mounted to bodily reciprocate relative to said tapering portion to increase or decrease the opening of the active valve member.

4. In an automatic flow-regulating valve, a stationary member having a shoulder and an elongated tapering portion extending therefrom; an active valve member mounted to bodily reciprocate relative to said tapering portion to increase or decrease the opening of the valve member, the opening of said valve being formed between said tapering portion and said active member.

5. In an automatic flow-regulating valve, a stationary member having a shoulder and an elongated tapering portion extending therefrom; an active valve member mounted to bodily reciprocate relative to said tapering portion, the opening to said valve being formed between said tapering portion and said active valve member; and means for normally maintaining said active member against said shoulder in which position the valve will be closed.

6. In an automatic flow-regulating valve, a shell having a plurality of perforations at its inlet end to permit of the passage of air therethrough; a stationary member fixed in said shell, and having an elongated tapering portion and a shoulder adjacent thereto; and an active member mounted to reciprocate relative to said tapering portion, and being disposed to shut off the passage of air from said perforations through said shell when adjacent to said shoulder, and to permit such passage of air more or less freely according to the distance removed from such shoulder.

7. In an automatic flow-regulating valve, a shell having a plurality of perforations at its inlet end to permit the passage of air therethrough; a stationary member fixed in said shell and having an elongated tapering portion and a shoulder adjacent thereto; an active moving member or disk mounted to reciprocate relative to said tapering portion, and being disposed to shut off the passage of air through said shell when adjacent to said shoulder, and to permit such passage of air more or less freely according to the distance removed from such shoulder; and a spring for normally maintaining said active member against said shoulder in the closed position whereby variations of the fluid pressure, from any cause, upon either face of the active member, will cause movement thereof to vary the area of the passage of the active member or valve disk.

8. In an automatic flow-regulating valve, a shell having a disk at its outer end provided with a plurality of perforations to permit the passage of air therethrough, a screw threaded bore in said disk; a stationary member having a screw threaded shank secured in said bore moving an inwardly extending tapering portion, and a shoulder between said shank and said tapering portion; an active member or disk mounted to reciprocate relative to said tapering portion and being disposed to shut off the passage of air from said perforations through said

shell when adjacent to said shoulder, and to permit such passage of air more or less freely according to the distance removed from said shoulder; and a spring for normally maintaining such active member or disk against said shoulder; the screw threaded connection between said shank and said disk permitting the tensional adjustment of said spring.

9. In an automatic flow-regulating valve, a shell having a diminished tapering outlet opening at its inner end; an inlet at its outer end; a screw threaded bore at the inlet end; a stationary member having a screw threaded shank in said bore, and an inwardly extending tapering portion, and a shoulder located between said shank and said tapering portion, the inner diminished end of said tapering portion being disposed in said diminished tapering opening of said shell; an active member mounted to reciprocate relative to said tapering portion and being disposed to shut off the passage of air from said perforations through said shell when adjacent to said shoulder, and to permit such passage of air more or less freely according to the distance removed from such shoulder; and a spring for normally maintaining said active member against said shoulder; the screw threaded connection between said shank and said disk permitting the tensional adjustment of said spring, and the adjustment of said tapering member relative to said diminished opening.

10. In an automatic flow-regulating valve, a shell having an inlet orifice at its outer end for the passage of fluid therethrough; a stationary member fixed in said shell and having an elongated tapering portion and a shoulder, there being an annular recess between said elongated portion and said shoulder; a sealing annular member or washer disposed in said annular recess; and an active moving member mounted to reciprocate relative to said tapering portion and having the outer cylindrical portion reciprocating, and fitting fluid tightly in the inside of said shell, an inward radially extending flange, and an inner cylindrical portion at the inner end of said flange through which said tapering portion extends; the inner cylindrical portion terminating in a seat to abut against said washer to shut off the passage of air from said inlet orifice through said shell, and to permit said passage of air more or less freely according to the distance removed from such washer, the opening of said valve being formed between said tapering portion of the stationary member and said active moving member, the tapering portion diminishing as it recedes from said washer, and thereby the opening formed between said active member and the tapering portion increasing as the active member recedes from said washer.

11. In an automatic flow-regulating-valve, a casing or shell having an inlet at one end and an outlet at the other; a tapered regulating spindle extending into the outlet; means for varying the position of the tapered spindle in the outlet so as to vary the area thereof; means for locking the tapered spindle in any desired position, and a moving member bodily reciprocated, having a central orifice located upon such spindle, such member being automatically moved by the pressure of the incoming fluid upon one side of such member, and moved reversely in the other direction by spring pressure.

12. In an automatic flow-regulating valve, a casing or shell having an inlet at one end and an outlet at the other; a tapered regulating-spindle extending into the outlet; means for varying the position of the tapered spindle in the outlet so as to vary the area thereof; means for locking the tapered spindle in any desired position; and a valve-disk or member having a central passage superposed upon the tapered spindle, fitting snugly at the periphery to the inner wall of the shell or casing, adapted to be automatically reciprocated upon such spindle, from the fully closed to the fully open positions, by variations of the pressure, from any cause, on either side of such valve-disk.

ALEXANDER S. BRUCE.

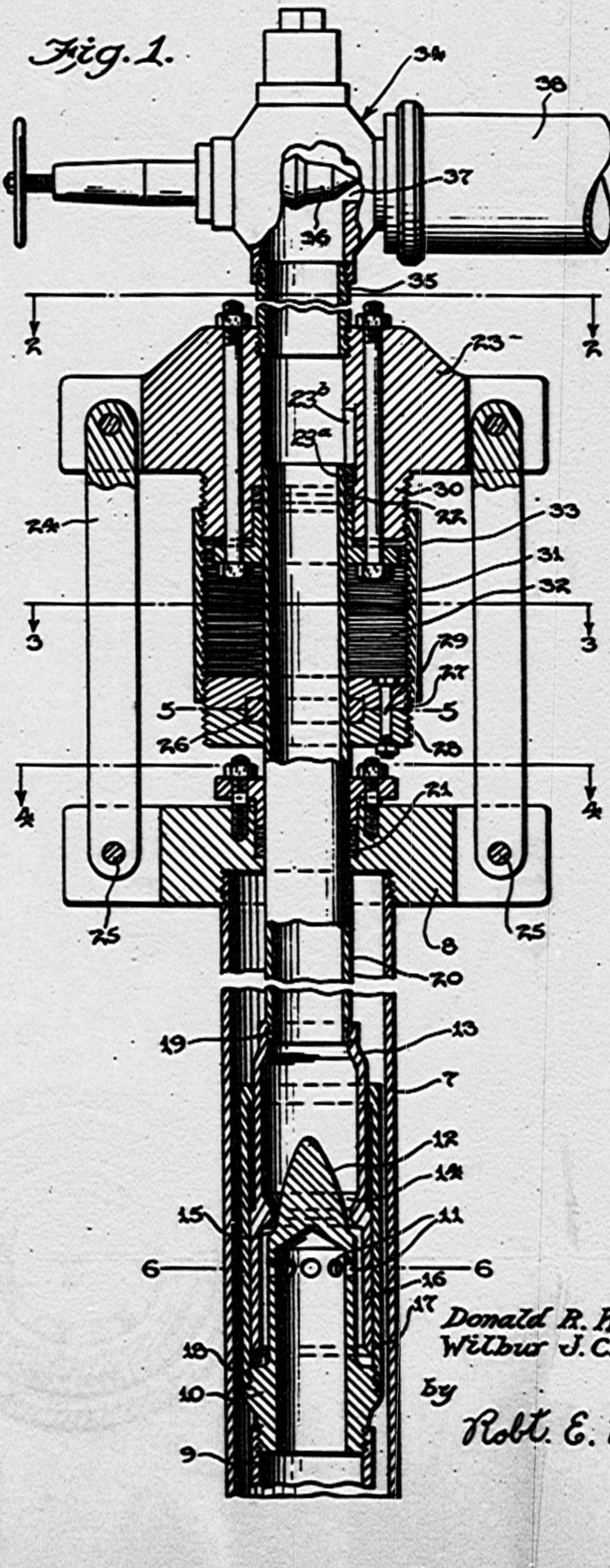
Witnesses:
L. Rooney,
E. P. Carlisle.

April 25, 1933. D. R. KNOWLTON ET AL 1,905,592

CONTROL DEVICE FOR WELLS

Filed Jan. 30, 1932 2 Sheets-Sheet 1

Fig. 1.



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April 25, 1933. D. R. KNOWLTON ET AL 1,905,592

CONTROL DEVICE FOR WELLS

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Fig. 2.

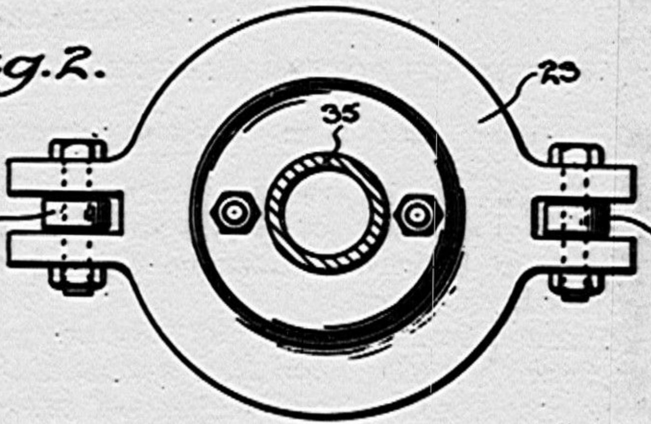


Fig. 3.

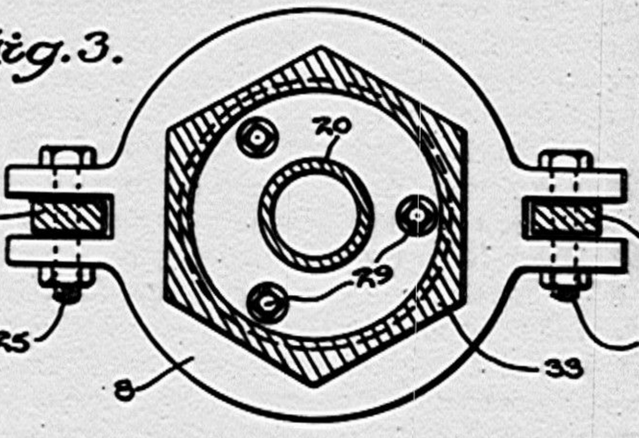


Fig. 4.

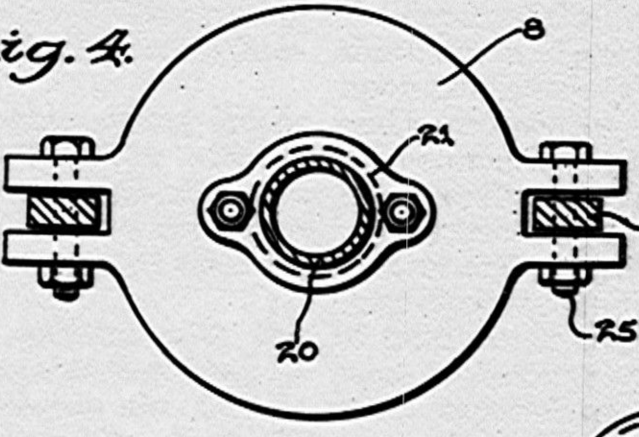


Fig. 6.

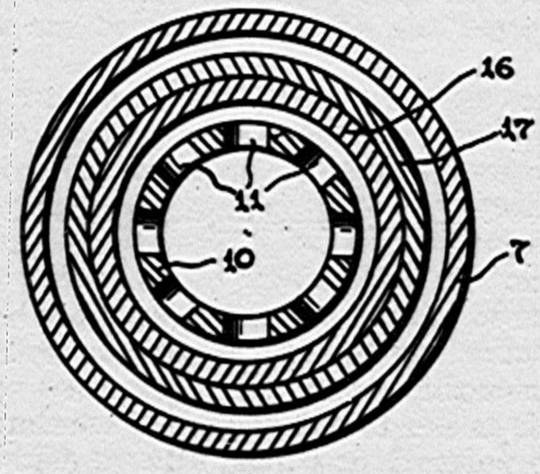
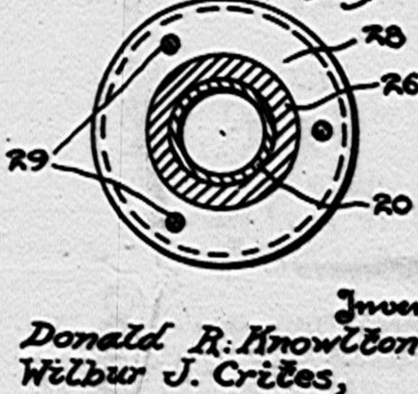


Fig. 5.



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# UNITED STATES PATENT OFFICE

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## CONTROL DEVICE FOR WELLS

Application filed January 30, 1932. Serial No. 589,952.

This invention relates to control devices for oil and gas wells, and more especially to novel control means including an adjustable bottom hole bean.

Such improvements can be used for controlling the flow of any fluid from a well, but they are particularly useful for regulating the flow of oil or gas from a well, either as a means of regulating the amount of oil and gas coming from the formation or as a medium for controlling gas that is introduced from the surface to provide a gas lift.

One of the objects of the invention is to supply the industry with a bottom hole bean of rugged construction, which can be placed in the well with a minimum of hazard, and which can be controlled by suitable means at the top of the well for easily and accurately regulating the bean in such manner that its area of opening can be noted at the surface at all times. Such control means permits the changing of the size of the opening through the bean, even while the well is flowing.

Another object is to provide control means which will permit the well to flow without restriction through the tubing while the bean is in the hole, and which may be caused to pinch down to any desired area of opening while the well is flowing.

A further object is to combine with the bottom hole bean, an adjustable flow bean at the top of the string which can also be adjusted if desired at the same time that adjustments are being made with the bottom hole bean.

A still further object is to provide control means for use with high pressure gas wells where the freezing of surface control equipment is a serious problem. By using an adjustable bottom hole bean made in accordance with the invention, the uniform year-round temperature at the bottom of the hole is taken advantage of and no surface choking is necessary. By such equipment, we can eliminate the expansion of gas at the surface, which usually results in freezing of equipment.

With the foregoing objects outlined and with other objects in view which will appear as the description proceeds, the invention consists in the novel features hereinafter described in detail, illustrated in the accompanying drawings, and more particularly pointed out in the appended claims.

In the drawings,

Fig. 1 is a vertical sectional view partly in elevation, of well equipment made in accordance with the invention.

Figs. 2 to 6 inclusive are transverse horizontal sectional views of the same, taken respectively on the lines 2—2, 3—3, 4—4, 5—5 and 6—6 of Fig. 1.

Before proceeding with a detail description of the device, it may be noted that in every oil well there is a certain amount of gas present with the oil. If the amount of gas is sufficient, the well will flow naturally. The gas-oil ratio of course, depends in each case on many factors, such as the size of the flow string, gravity of the oil, and the depth of the well. The velocity at which this column of gas moves has a direct bearing upon the quantity of oil that it can carry, and consequently, upon the gas-oil ratio. If the column moves too slowly, excessive slippage results, and if too rapidly, there is excessive friction and turbulence. By means of bottom and surface adjustable beans on the same flow string, the velocity of the column of fluid can be easily controlled, whereby the same or better results can be obtained than when tapered tubing is used without this regulation.

Referring to the drawings, 7 designates conventional well casing provided at its upper end with a casing head 8.

At any desired elevation in the casing, we secure by a conventional hook wall anchor 9, a valve head 10 which forms part of the stationary element of the bottom hole bean. This member is hollow and provided with apertures 11 for the exit of rising fluid. A substantially cone-shaped tip 12 is provided at the upper end of said head.

The movable member 13 of the bottom bean consists of a sleeve having an internal annular shoulder 14 which surrounds the tip of the head 10 and can, when desired, rest on the shoulder 15 of the head to completely cut off those skilled in the art, and it is apparent that changes may be made in the details disclosed, without departing from the spirit of the invention, as expressed in the claims.

What we claim and desire to secure by Letters Patent is:

1. The combination in a well having a casing and tubing, of a plurality of adjustable beans for controlling the flow of fluid through the tubing, one of said beans being submerged and the other being positioned at the top of the tubing, and means at the top of the well for adjusting both beans.

2. The combination in a well having a casing and tubing, of a plurality of adjustable beans for controlling the flow of fluid through the tubing, one of said beans being submerged and the other being positioned at the top of the tubing, and adjustable means at the top of the well for adjusting the size of the openings through said beans from the top of the well.

3. The combination with a well having a casing and tubing, of a bottom hole bean, means for regulating the size of the opening through said bean by moving the tubing in a rectilinear path from the top of the well, means for preventing rotation of the tubing during such rectilinear movement, and means for preventing fluid pressure within the tubing or casing from moving the tubing.

4. The combination with a well having a casing and tubing, of a bottom hole bean, means for regulating the size of the opening through said bean by moving the tubing in a rectilinear path from the top of the well, means for preventing rotation of the tubing during such rectilinear movement, said bean including a stationary tube, a head fixed to the stationary tube and having an apertured portion projecting into the tube, and a sleeve slidable in the stationary tube and having an annular shoulder cooperating with said head.

5. The combination with a well having a casing and tubing, of a bottom hole bean, means for regulating the size of the opening through said bean by moving the tubing in a rectilinear path from the top of the well, means for preventing rotation of the tubing during such rectilinear movement, said bean including a stationary tube, a head fixed to the stationary tube and having an apertured portion projecting into the tube, and a sleeve slidable in the stationary tube and having an annular shoulder cooperating with said head, the head having a substantially conical tip which cooperates with the shoulder.

6. The combination with a well having a casing and tubing, of a bottom hole bean, means for regulating the size of the opening through said bean by moving the tubing in a rectilinear path from the top of the well, means for preventing rotation of the tubing during such rectilinear movement, said bean including a stationary tube, a valve head fixed to the stationary tube and projecting upwardly into the latter, the upper end portion of the head terminating in a substantially conical tip, the valve head being apertured below said tip, and a sleeve slidable in the stationary tube and having an annular shoulder adapted to seat on said tip, the sleeve having a skirt projecting downwardly below the apertured portion of the head.

7. The combination with a well having a casing and tubing, of a bottom hole bean, means for regulating the size of the opening through said bean by moving the tubing in a rectilinear path from the top of the well, and means for preventing rotation of the tubing during such rectilinear movement, the means for moving the tubing in a rectilinear path comprising a rotatable nut having right and left hand threads, a stationary threaded member engaging one thread of the nut, and a vertically movable threaded member fixed to the tubing and engaging the other thread of the nut.

8. In a well, tubing and a casing, a casing head secured to the top of the casing, a tubing head on the tubing, a portion of the tubing being slidably mounted in the casing head and also in the tubing head, a stationary threaded part on the tubing head, a threaded part connected to the tubing, and a nut having right and left hand threads engaging said threaded parts.

9. In a well, tubing and a casing, a casing head secured to the top of the casing, a tubing head, a portion of the tubing being slidably mounted in the casing head and also in the tubing head, a stationary threaded part on the tubing head, a threaded part connected to the tubing, a nut having right and left hand threads engaging said threaded parts, and links detachably connecting said heads.

10. The combination in a well having a vertical pipe comprising an upper stationary section and a lower vertically movable section connected together by a telescopic joint, of an adjustable surface flow bean mounted on the upper end of said stationary section, a submerged adjustable flow bean associated with the movable section, and means cooperating with the movable section and positioned below the surface flow bean for adjusting the submerged bean without disturbing the surface bean.

In testimony whereof, we hereto affix our signatures.

DONALD R. KNOWLTON.
WILBUR J. CRITES.

the flow. A skirt 16 forms part of the sleeve and snugly engages the inner surface of a tube 17 which is fixed to the head by a threaded connection 18. This skirt prevents sand from getting in between the sleeve and tube, and thereby prevents sand from interfering with the adjustment of the sleeve.

The sleeve is raised or lowered by a rectilinear motion and without rotation for the purpose of regulating the area of the opening between the shoulder 14 and the tip 12, and for this purpose, the sleeve is joined by a threaded connection 19 to a conventional tubing string 20.

The upper section of the tubing string passes through a packing gland 21 on the casing head, and a packing gland 22 on the tubing head 23. A spline 23*a* fixed to the tubing 20, slides in a vertical groove 23*b* in the head 23, to prevent turning of the tubing string 20.

These heads are connected to one another by links 24 which are joined to the casing head by means of removable pins 25, so that the tubing head can be removed when it is desired to take the tubing out of the well.

The upper section of the tubing has fixed to the same, an annular flange 26 which fits within a threaded collar formed of an upper section 27 and a lower section 28, and these sections are secured together by any suitable means such as bolts 29.

The tubing head also has a depending threaded portion 30 and threads of which extend in a different direction from the threads of the part 27, 28, and these threads engage respectively with right and left hand threads 31 and 32 of a nut 33.

It will be understood that as the upper tubing section can slide in the glands 21 and 22, that when the nut 33 is rotated, the tubing will move rectilinearly without rotation, and this will result in lifting or lowering of the skirt 13, depending on the direction of rotation of the nut.

We preferably use with this arrangement, a surface control bean 34 which may be of the type disclosed in the U. S. patent to Donald R. Knowlton, No. 1,831,713, dated November 10, 1931. This bean is connected by a piece of tubing 35 to the tubing head, and its manually adjusted substantially cone-shaped head 36 cooperates with a choke opening 37, through which the fluid flows into a flow pipe 38 which leads the same to an oil and gas separator, not shown.

This apparatus will enable those in the industry to control the gas-oil ratio.

Another equally important advantage of the bottom hole bean resides in the fact that it prolongs the flowing life of oil wells. Many wells that either flow by heads or by artificial means, such as gas lift or pumping, can be made to flow steady by the use of our bottom hole bean.

One of the distinct advantages of the bottom hole bean in a gas lift well, is that there is little back pressure against the column of fluid in the tubing. Friction in the tubing, and the natural weight of the fluid column, are the natural forces working against the upward energy causing the flow. Where only the surface bean is used, the expanding gas dissipates energy which otherwise might be utilized.

To our knowledge all other bottom hole beans which are adjustable, can only be adjusted by twisting or turning either rods or tubing, which methods have many disadvantages. Also, to our knowledge, no other adjustable bottom hole bean will permit an unrestricted flow through the bean if desired, for the purpose of taking an open flow or potential gauge of the well. Naturally, this is a decided advantage, as it eliminates the necessity of "killing the well" to remove the bean if open flow is desired. The common practice at the present time is to use replaceable non-adjustable beans of various sizes because of the disadvantages of the existing types of adjustable bottom hole beans. Our bean, on the other hand, is adaptable to all conditions and types of wells, such as gas-lift, flowing oil wells, or gas wells, and offers a more simple and effective means of regulating at the surface the flow of oil or gas from the well by means of a bottom hole bean.

In operation, the surface flow bean 34 will be opened. The bottom hole bean may then be opened by turning the nut 33 to the right so that the threaded member 27, 28 will act on the flange 26 to lift the tubing 20. Obviously, as the latter rises, the sleeve 13 will lift the shoulder 14 from the ledge 15, and the oil and gas will flow through the orifices 11 and into the sleeve, and thence through the tubing to the surface. Any size opening at the bottom up to the full size of the tubing can be obtained, and this is also true of the top bean 34. This makes it possible to obtain a pressure differential between the formation and the inside of the tubing ranging from zero to the maximum formation pressure. With such pressure differential, it is apparent that perfect control of flowing conditions are obtained. Also, when the volume and pressure of the gas are not sufficient to flow the well, gas can be introduced into the well between the casing and tubing, and artificial flow can be realized under the same conditions of perfect control as were obtained under natural flow. Introduced gas will flow downward between the casing and tubing, between the slips, (not shown) of the anchor 9, and into the bottom hole bean through the same course as the formation gas.

From the foregoing it is believed that the construction, operation and advantages of the invention may be readily understood by those skilled in the art, and it is apparent that changes may be made in the details disclosed, without departing from the spirit of the invention, as expressed in the claims.

What we claim and desire to secure by Letters Patent is:

1. The combination in a well having a casing and tubing, of a plurality of adjustable beans for controlling the flow of fluid through the tubing, one of said beans being submerged and the other being positioned at the top of the tubing, and means at the top of the well for adjusting both beans.

2. The combination in a well having a casing and tubing, of a plurality of adjustable beans for controlling the flow of fluid through the tubing, one of said beans being submerged and the other being positioned at the top of the tubing, and adjustable means at the top of the well for adjusting the size of the openings through said beans from the top of the well.

3. The combination with a well having a casing and tubing, of a bottom hole bean, means for regulating the size of the opening through said bean by moving the tubing in a rectilinear path from the top of the well, means for preventing rotation of the tubing during such rectilinear movement, and means for preventing fluid pressure within the tubing or casing from moving the tubing.

4. The combination with a well having a casing and tubing, of a bottom hole bean, means for regulating the size of the opening through said bean by moving the tubing in a rectilinear path from the top of the well, means for preventing rotation of the tubing during such rectilinear movement, said bean including a stationary tube, a head fixed to the stationary tube and having an apertured portion projecting into the tube, and a sleeve slidable in the stationary tube and having an annular shoulder cooperating with said head.

5. The combination with a well having a casing and tubing, of a bottom hole bean, means for regulating the size of the opening through said bean by moving the tubing in a rectilinear path from the top of the well, means for preventing rotation of the tubing during such rectilinear movement, said bean including a stationary tube, a head fixed to the stationary tube and having an apertured portion projecting into the tube, and a sleeve slidable in the stationary tube and having an annular shoulder cooperating with said head, the head having a substantially conical tip which cooperates with the shoulder.

6. The combination with a well having a casing and tubing, of a bottom hole bean, means for regulating the size of the opening through said bean by moving the tubing in a rectilinear path from the top of the well, means for preventing rotation of the tubing during such rectilinear movement, said bean including a stationary tube, a valve head fixed to the stationary tube and projecting upwardly into the latter, the upper end portion of the head terminating in a substantially conical tip, the valve head being apertured below said tip, and a sleeve slidable in the stationary tube and having an annular shoulder adapted to seat on said tip, the sleeve having a skirt projecting downwardly below the apertured portion of the head.

7. The combination with a well having a casing and tubing, of a bottom hole bean, means for regulating the size of the opening through said bean by moving the tubing in a rectilinear path from the top of the well, and means for preventing rotation of the tubing during such rectilinear movement, the means for moving the tubing in a rectilinear path comprising a rotatable nut having right and left hand threads, a stationary threaded member engaging one thread of the nut, and a vertically movable threaded member fixed to the tubing and engaging the other thread of the nut.

8. In a well, tubing and a casing, a casing head secured to the top of the casing, a tubing head on the tubing, a portion of the tubing being slidably mounted in the casing head and also in the tubing head, a stationary threaded part on the tubing head, a threaded part connected to the tubing, and a nut having right and left hand threads engaging said threaded parts.

9. In a well, tubing and a casing, a casing head secured to the top of the casing, a tubing head, a portion of the tubing being slidably mounted in the casing head and also in the tubing head, a stationary threaded part on the tubing head, a threaded part connected to the tubing, a nut having right and left hand threads engaging said threaded parts, and links detachably connecting said heads.

10. The combination in a well having a vertical pipe comprising an upper stationary section and a lower vertically movable section connected together by a telescopic joint, of an adjustable surface flow bean mounted on the upper end of said stationary section, a submerged adjustable flow bean associated with the movable section, and means cooperating with the movable section and positioned below the surface flow bean for adjusting the submerged bean without disturbing the surface bean.

In testimony whereof, we hereto affix our signatures.

DONALD R. KNOWLTON.
WILBUR J. CRITES.

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**July 25, 1933.** H. C. OTIS **1,920,103**

WELL TOOL

Filed Dec. 1, 1930 3 Sheets-Sheet 1

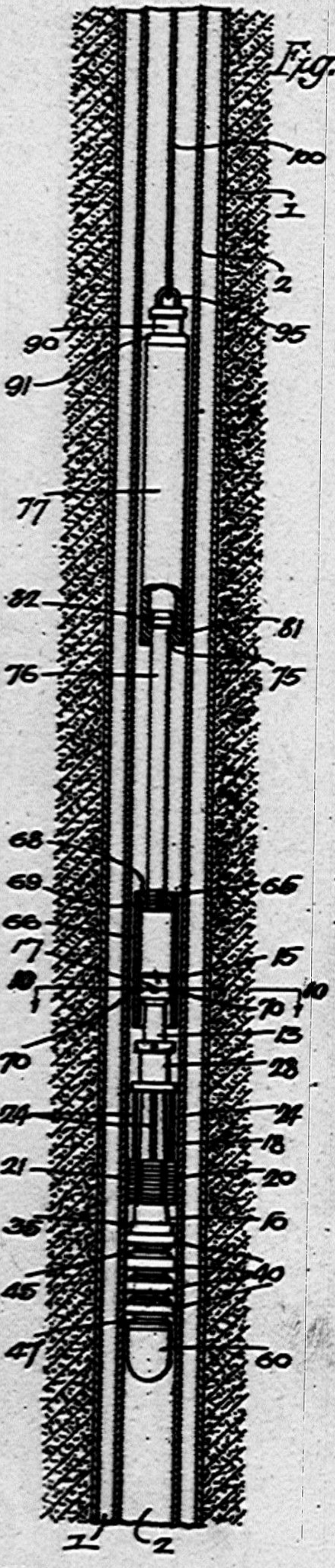
Fig. 1.

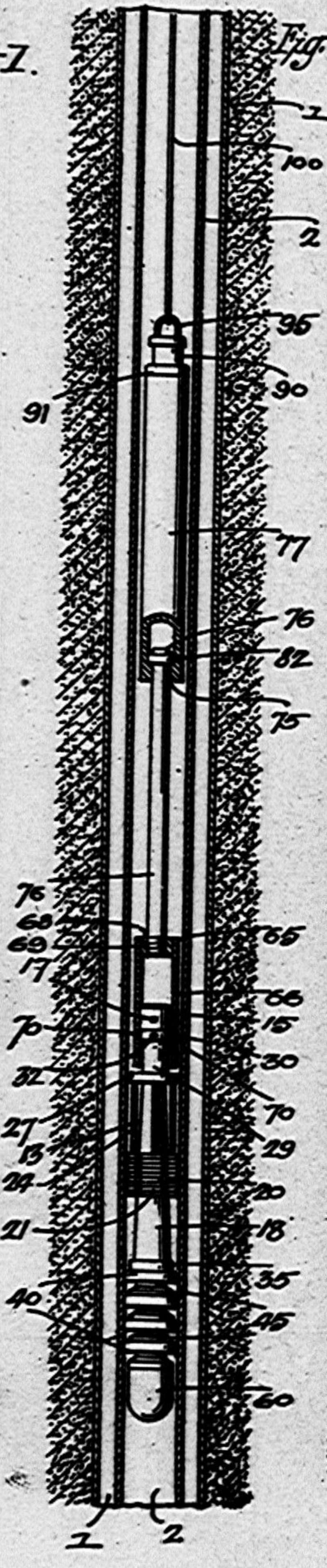
Fig. 2.

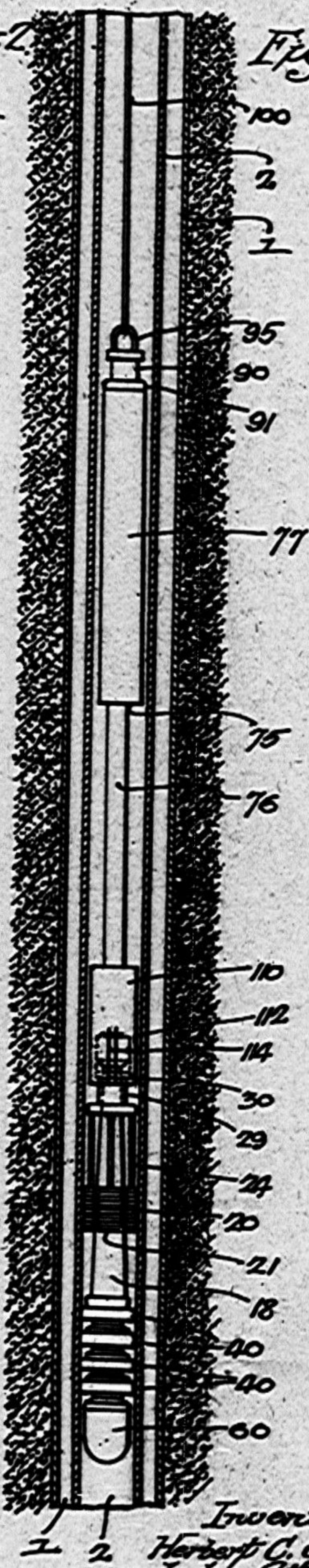
Fig. 3.

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July 25, 1933. H. C. OTIS 1,920,103

WELL TOOL

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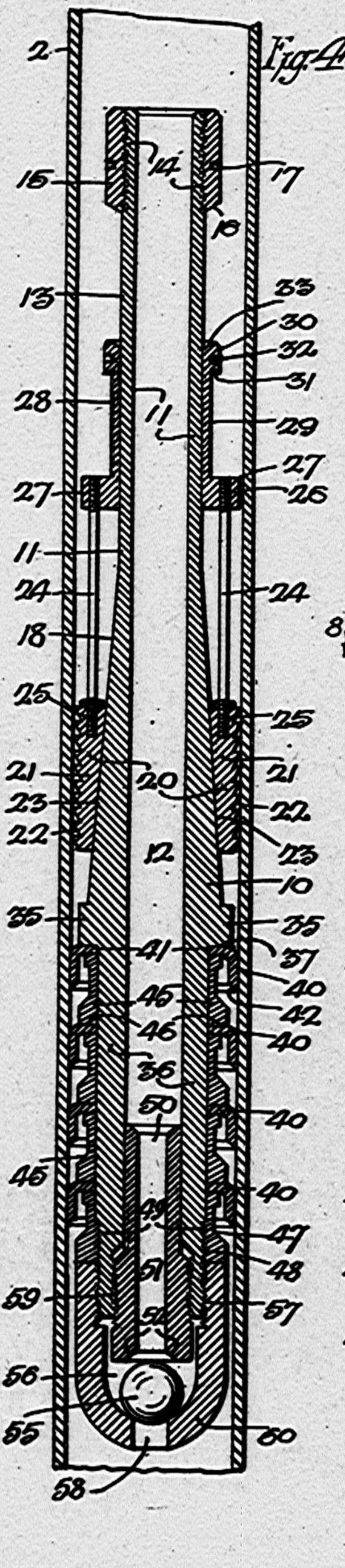
Fig. 4.

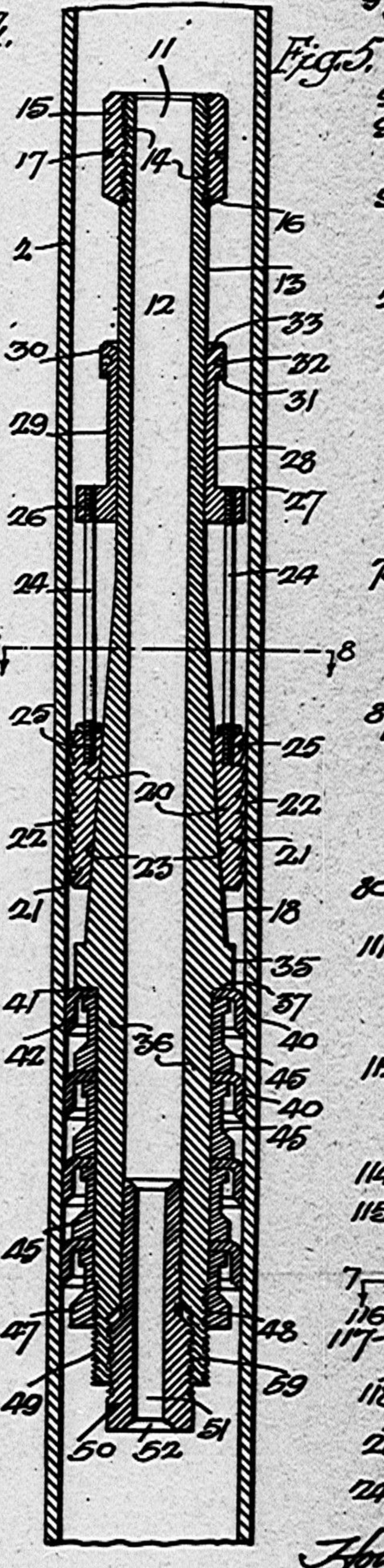
Fig. 5.

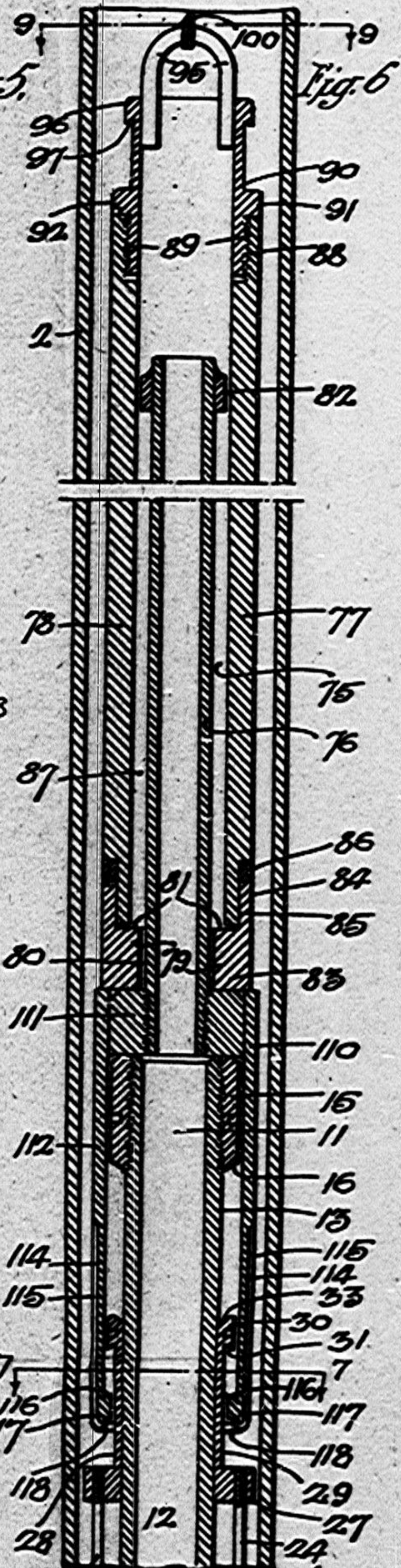
Fig. 6

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WELL TOOL

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Fig. 13

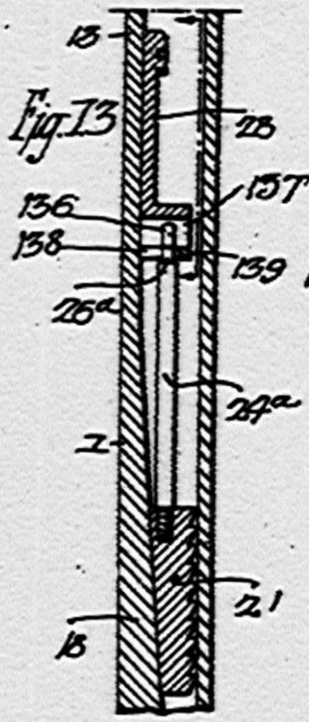


Fig. 7

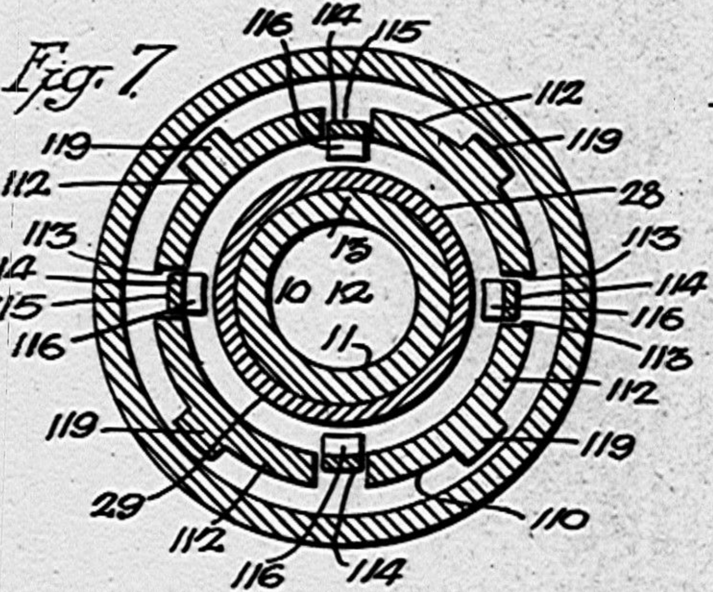


Fig. 12

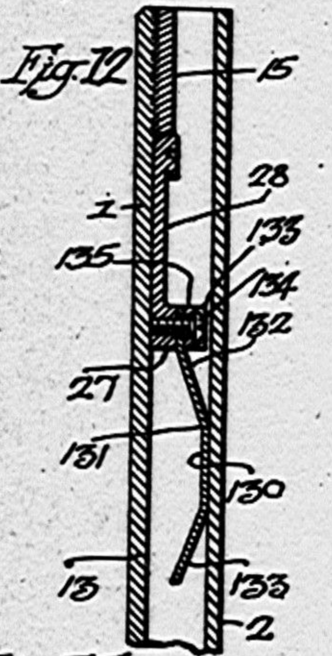


Fig. 14

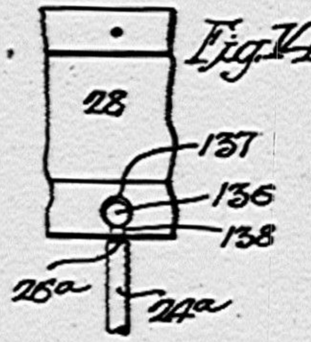


Fig. 8

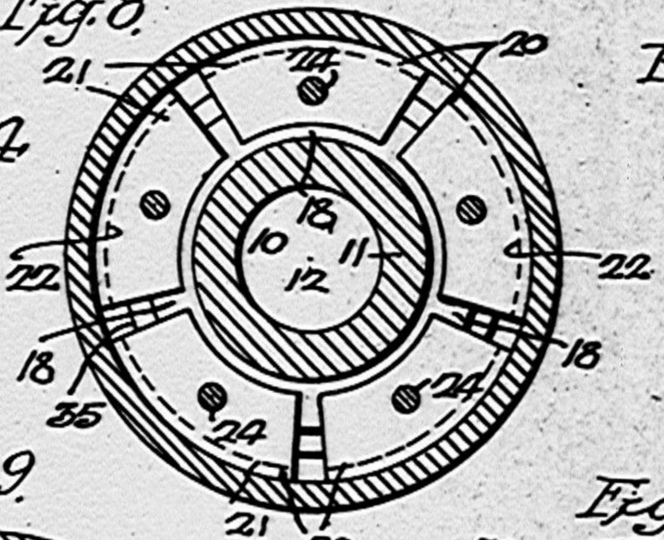


Fig. 11

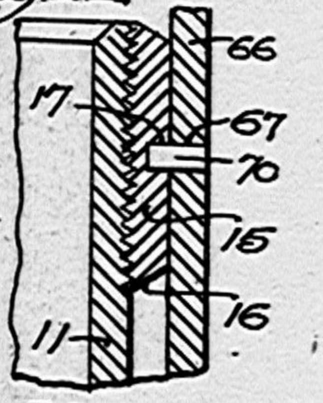


Fig. 9

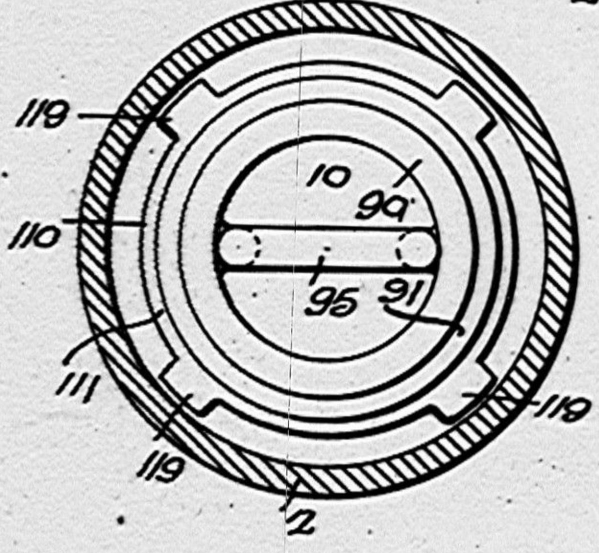
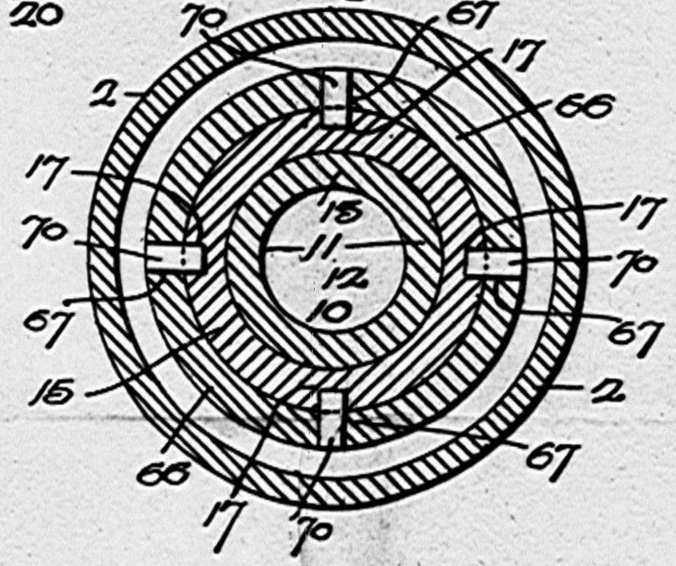


Fig. 10



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**Patented July 25, 1933** **1,920,103**

# UNITED STATES PATENT OFFICE

HERBERT C. OTIS, OF SHREVEPORT, LOUISIANA

## WELL TOOL

Application filed December 1, 1930. Serial No. 499,372.

REISSUED

This invention relates to an obstructive device adapted for use as either a plug or choke for a string of tubing located within the casing of a flowing oil well operating under high pressure, in order that the string of tubing may be withdrawn completely from the well casing, or shifted longitudinally within the well casing to change the position of the inlet or screen section of the tubing relative to the bottom of the well.

Experience has proven that the position of the inlet or screen section of a string of tubing, with respect to the bottom of the well in which the tubing is set, frequently affects the oil and gas production of a flowing oil well operating under high pressure; and that by raising or lowering the string of tubing a short distance in the well the production of both oil and gas may be varied materially.

One object of the present invention is to provide a practical and efficient device capable of being used as a tubing seal, or as a tubing choke, which may be readily set at any desired place in the string of tubing and which may be readily removed from the string of tubing without "pulling" the string of tubing.

Another object of the invention is to provide an actuating device in conjunction with a setting tool or with a pulling tool, co-operating with the obstructive device, whereby the obstructive device may be lowered into or removed from the string of tubing and whereby the sealing or choking device may be set in the tubing or released therefrom.

Other objects of the invention and the construction of the device, in detail, will be fully disclosed hereinafter, reference being had to the accompanying drawings, of which:

Fig. 1 is a longitudinal sectional elevation through a portion of a well casing showing a string of tubing set within the casing; and the assembled actuating, setting and obstructive devices as being lowered within the said string of tubing;

Fig. 2 is a view similar to Fig. 1, but showing an alternative manner of attaching the setting and actuating device to the obstructive device;

Fig. 3 is a view similar to Fig. 1, but showing the obstructive device as being withdrawn from the string of tubing by use of a pulling device interposed between the actuating and obstructive devices;

Fig. 4 is a longitudinal sectional elevation, drawn on an enlarged scale, showing the obstructive device being used as a temporary seal, for the string of tubing;

Fig. 5 is a view similar to Fig. 4, but showing certain elements of the obstructive device removed to cause the obstructive device to function as a choke for the string of tubing;

Fig. 6 is a view similar to either Fig. 4 or Fig. 5, and showing the pulling and actuating devices in operative position with respect to the obstructive device, to effect release of the obstructive device from the wall of the string of tubing, to permit the obstructive device to be removed from the string of tubing.

Fig. 7 is a sectional plan view taken on the line 7—7, Fig. 6;

Fig. 8 is a sectional plan view taken on the line 8—8, Fig. 5;

Fig. 9 is a sectional plan view taken on the line 9—9, Fig. 6;

Fig. 10 is a sectional plan taken on the line 10—10, Fig. 1;

Fig. 11 is a sectional elevation taken on the line 11—11, Fig. 10; and

Figs. 12, 13 and 14 illustrate modified forms of details of the invention.

Referring to Figs. 1, 2 and 3 of the drawings, a portion of a well casing is indicated at 1. Within the casing 1 is located a string of tubing 2, and within the string of tubing 2 is located an obstructive device 10, which forms the subject of the present invention.

The obstructive device 10, see Fig. 4, comprises a mandrel 11 having a central axial bore 12 extending completely through the mandrel from end to end thereof. The mandrel 11 comprises an upper straight walled cylindrical section 13 threaded at 14, adjacent its upper end, for the reception of an externally disposed collar 15. The lower edge of the collar 15 is beveled, as indicated at 16, for purposes hereinafter set forth. The collar 15 is provided with a plurality of openings 17, 17, for purposes hereinafter set forth.

Below the cylindrical section 13, the mandrel 11 is provided with a frusto-conical section 18, around which is disposed a longitudinally split gripping element 20, composed of a plurality of independent segmental slip sections 21. Each of the slip sections 21 is provided on its outer peripheral surface with a plurality of annular teeth 22 which are adapted to engage the inner surface of the string of tubing 2, to maintain the obstructive device 10 in a predetermined position within the string of tubing 2.

The inner surfaces 23 of the assembled segmental sections 21, of the gripping element 20, taper in accordance with the taper of the external surface of the frusto-conical section 18 of the mandrel 11, so that, upon relative longitudinal movement being effected between the gripping element 20 and the frusto-conical section 18, of the mandrel 11, the gripping element 20 will be caused to expand or contract, to effect either engaging or releasing movement, as the case may be, of the teeth 22, of the gripping element 20, with respect to the inner surface of the string of tubing 2.

Each of the segmental slip sections 21 of the gripping element 20 is supported by a spring tongue 24 which, in the present instance, is in the form of a circular rod having one end 25 threaded into a suitably threaded opening in the upper end of the slip section 21, the opposite end 26 of the rod 24 being threaded into a suitably threaded opening formed in an annular flange 27 of a slip carrier 28 which surrounds and is adapted to slide on the upper cylindrical section 13 of the mandrel 11.

The slip carrier 28 comprises a cylindrical body section 29 extending vertically from the annular flange 26 and is provided at its upper end with an annular flange 30 having a radially undercut lower edge 31 and a plurality of openings 32 formed in and spaced circumferentially of the outer peripheral surface of the annular flange 30, for purposes hereinafter set forth.

The upper edge of the slip carrier 28 is beveled as shown at 33 for engagement with the lower bevel edge 16 of the collar 15 of the mandrel 11, as will be fully explained hereinafter.

At the lower end of the frusto-conical section 18 the mandrel 11 is provided with an annular flange 35 and below the flange 35 the mandrel 11 is provided with a lower straight walled cylindrical section 36, of relatively smaller diameter than the flange 35 providing a shoulder 37 on the mandrel, formed by the lower face of the flange 35.

Surrounding the lower cylindrical section 36 of the mandrel 11 is a plurality of cup washers 40 each having a horizontally disposed portion 41 and a vertically disposed annular flange 42. The outer surfaces of the cup elements 40 are adapted to be forced into sealing contact with the inner surface of the string of tubing 2 to form a seal between that portion of the string of tubing lying below the obstructing device 10 and that portion of the string of tubing lying above the said obstructing device 10.

The uppermost of the cup washers 40 abuts against the shoulder 37 on the mandrel 11 and is held in position by a spacing ring 45. The lower surface of the ring 45 provides an abutment 46 for the next lower cup washer 40, one of such spacing rings 45 being provided between each adjacent pair of the cup washers 40.

The lowermost cup washer 40 is maintained in position by a locking ring 47, which is similar in construction to the spacing rings 45 with the exception that the locking ring 47 is provided with internal threads 48 that are adapted to cooperate with external threads 49 formed on the lower end of the outer surface of the lower cylindrical section 36 of the mandrel 11.

Within the bore 12 of the mandrel 11, adjacent the lower end of the lower cylindrical section 36 thereof, the said mandrel is provided with a valve or choke bushing 50 having a central bore 51 adapted to permit a flow through the obstructing device 10 under predetermined conditions. The lower end of the bore 51 of the bushing 50 is beveled, as indicated at 52, to provide a seat for a ball valve 55 which is confined in a chamber 56.

The valve chamber 56 is formed within a valve-retaining element 60, which is provided with a square opening 58 in axial alignment with the bore 51 of the valve bushing 50. The valve-retaining element 60 is internally threaded as indicated at 57 for the reception of the external threads 49 of the mandrel 11, whereby the said retaining element 60 is secured to the lower end of said mandrel.

The lower end of the mandrel 11 is counterbored and threaded as illustrated at 59 for the reception of a correspondingly threaded portion of the valve or choke bushing 50 whereby the said valve bushing is maintained within the bore 12 of the mandrel 11.

When the obstructing device 10 is used as a choke within a string of tubing the retaining element 60 and the ball valve 55 are eliminated to permit a predeterminately restricted flow from the lower part of the string of tubing to the upper part thereof, through the bore 51 of the bushing 50 and the bore 12 of the mandrel 11, the bore 5

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of the bushing 50 in such case being of a predetermined diameter to produce a predetermined choking or restriction of the flow of fluid through the string of tubing 2, as clearly shown in Fig. 5.

The obstructing device 10, above described, is adapted to be introduced to, removed from, and operated within the string of tubing 2 without allowing the escape of fluid pressure therefrom by the use of surface equipment, such as shown and described in my co-pending application, Serial No. 431,-510, filed February 26, 1930.

In the present instance the lowering of the obstructing device 10 into the string of tubing 2 and the setting of said device within the string of tubing is effected by means of a setting tool 65, coupled to and carried on the lower end of an actuating or jarring device 75, which in turn is suspended within the well tubing on an ordinary form of round steel measuring line 100, see Figs. 1 and 2.

The setting tool 65 comprises a hollow cylindrical body section 66 in which, at a predetermined distance above the lower open end thereof, is formed a plurality of openings 67, see Figs. 10 and 11. Located in each of the openings 67 is a relatively soft metallic plug or rivet 70 which may be of copper, brass, or any other desired material. The plugs or pins 70 project inwardly toward the center of the setting tool 65 to enter either the openings 17 of the collar 15 on the upper end of the mandrel 11 as shown in Figs. 1, 10 and 11, or to enter the openings 32 formed in the upper annular flange 30 of the slip carrier 28, as illustrated in Fig. 2. The upper end of the setting tool 65 is provided with an inwardly extending annular flange 68 forming a head having a threaded opening 69 for the reception of the lower threaded end of a central tubular element 76, forming part of the jarring device 75.

The jarring device 75 is of a telescopic construction, see Fig. 6, of which the tubular element 76 forms the inner element while an outer sleeve element 77 is provided to slide longitudinaly of the inner section 76 on the outer surface thereof.

The outer sleeve section 77 of the telescopic jarring device 75 comprises a tubular body portion 78 having an internal annular flange 79 at its lower end which is provided with a central bore 80 through which the inner tubular section 76 is adapted to slide.

The upper surface of the internal flange 79 provides a shoulder 81 on which the lower surface of a collar 82, that is suitably secured, as by welding, to and adjacent the upper end of the inner section 76 of the said telescopic jarring device, is adapted, under certain conditions, to rest.

In the present instance, the internal flange 79 is formed at the lower end of the outer section 77 of the telescopic jarring device 75 by an annular element 83, having a vertically extending flange 84. The lower portion of the body portion 78 is reduced in diameter, as indicated at 85, to receive the flange 84 of the annular element 83, which is secured to said reduced portion of the body element by welding, as indicated at 86. The outer diameters of the vertically extending flange 84 and the annular element 83 are substantially equal to the outer diameter of the body portion 78 of said jarring device. The central bore 80 of the annular element 83 is of a diameter slightly greater than the outer diameter of the inner tubular section 76 of said jarring device, and the bore 87 of the body portion 78 of the jarring device 75 is slightly larger in diameter than the outer diameter of the collar 82 on the upper end of the inner tubular section 76 of the jarring device 75, whereby the two relatively movable sections 76 and 77 of the telescopic jarring device 75 will be axially guided in their relative movements with respect to each other.

The upper end of the body portion 78 of the outer sleeve section 77 of the telescopic jarring device 75 is counterbored and threaded as indicated at 88 for the reception of the threaded end 89 of a bail carrier 90. The bail carrier 90 is provided with an annular flange 91 providing a shoulder 92 adapted to be jammed down tightly against the surface of the upper end of the body portion 78, whereby the bail carrier 90 will be securely connected to the outer sleeve section 77 of the telescopic jarring device 75. In the upper open end of the bail carrier 90 and extending across said carrier from side to side thereof is a bail 95 to which the one end of the suspending line 100 is secured.

The said bail carrier 90 is provided at its upper end and the annular flange 96 having an under cut shoulder 97 providing means by which the jarring device may be engaged by a fishing device, forming no part of the present invention, in the event of either the suspending line 100 or the bail 95 breaking during the course of operations attending the setting or removal obstructing device 10, in the string of tubing 2. Such a fishing device comprises a plurality of hooks operatively connected to a suitable carrier which may be suspended within the string of tubing on the suitable line similar to the line 100, until the hooks take hold under the flange 96 of the bail carrier 90.

The assembled unit comprising the obstructing device 10, the setting tool 65 and the jarring device 75 may be run into the string of tubing 2 in either of the two ways shown in Figs. 1 and 2 respectively.

As shown in Fig. 1, the setting tool 65 is coupled at its upper end to the jarring device and at its lower end directly to the collar 15 on the upper end of the mandrel 11, the soft metal rivets or connecting plugs 70 passing through the openings 67 in the setting tool 65 and into the openings 17 formed in the collar 15, thereby rigidly securing the setting tool to the mandrel of the obstructing device.

In employing the method shown in Fig. 1, the spring tongues 24, which carry the slip elements 21, are flexed outwardly, so that the said slip elements will drag along the inside surface of the tubing. The assembly is then introduced into the upper end of the string of tubing and lowered within said tubing in the manner and by the same apparatus described in the co-pending application, Serial No. 431,510 before mentioned, no flow being permitted through the string of tubing during this operation.

When the assembly has been lowered to the desired depth, by paying out the suspending wire 100 through the controlling mechanism located at the upper end of the string of tubing as described in the co-pending application, an upward pull exerted on the suspending wire 100 will move the mandrel 11 upwardly through the securing element 20 and the carrier 28. Since the slip elements 21 of the securing element 20 are engaging lightly against the inner wall of the tubing, raising of the mandrel 11 will cause the holding element 20 to be expanded radially, thereby jamming the slip elements 21 against the inner wall of the tubing, which sets the obstructing element 10 against any further upward movement in and with respect to the string of tubing 2.

The coupling plugs 70, which connect the mandrel 11 to the setting tool 65, have sufficient shear strength or shear resistance to enable the slip elements 21 to be firmly set against the inner wall of the tubing and the jamming of the frusto-conical section 18 of the mandrel in the tapered opening of the securing element 20 produces sufficient friction between the two to maintain the mandrel in the position to which it has been set. Sufficient force is then applied to the suspending wire 100 to cause a relative upward movement of the setting tool 65 with respect to the collar 15 at the mandrel 11, causing the connecting plugs 70 to be sheared, thereby releasing the setting tool 65 from the said mandrel and leaving the obstructing device in its set position within the string of tubing, as indicated in Figs. 4 and 5.

The shearing of the connecting plugs 70 may be effected by paying out the wire 100 after the obstructing device has been set until the lower surface of the outer sleeve section 77 of the jarring device 75 comes to rest on the upper surface of the internal flange 73 of the setting tool 65, whereafter a sudden upward movement of the wire 100 and consequently the said sleeve section 77 may be effected with respect to the inner section 76 of said jarring device, whereupon the upper surface 81 of the internal flange at the lower end of the said outer sleeve section will strike the under surface of the collar 82 on the inner section of the telescopic device 75 a hammer blow of sufficient force to cause the shearing of the connecting plugs 70.

After the shearing of the plugs 70 which disconnects the setting tool from the obstructing device the said setting tool and the jarring device 75 are removed from the well by manipulation of the controlling elements at the upper end of the string of tubing, in the manner described in the said co-pending application.

After the jarring device and setting tool have been removed from the string of tubing the valve controlling the flow of fluid through the string of tubing is opened, whereupon a flow of fluid upwardly through the string of tubing starts immediately. This flow of fluid, in trying to pass through the obstructing device when the device is used as a seal, as in Fig. 4, raises the ball valve 55 in the chamber 56 into engagement with the valve seat 52 at the lower end of the bushing 50 located at the lower end of the mandrel 11. Thus the flow of fluid through the bore 12 of the mandrel is stopped. The flow of fluid in attempting to pass around the closed obstructing device will cause the flange sections 42 of the cup washers 40, disposed around the outside of the mandrel 11, to be forced into sealing contact with the inner surface of the string of tubing, thus effectively sealing the string of tubing against a flow of fluid therethrough.

The other method of running in and setting the obstructing device 10 in the string of tubing, whether the device is to be used as a plug or choke, is to fasten the setting tool 65 to the slip carrier 28 in the manner indicated in Fig. 2, the soft metal connecting plugs 70 passing through the openings 67 in the setting tool and into the openings 32 formed in the upper annular flange 30 of the carrier 28. The entire assembly is then introduced to and lowered within the string of tubing through the controlling means at the upper end of the string of tubing, in the manner noted in the above mentioned co-pending application, Serial No. 431,510, no flow of fluid through the tubing being permitted while the assembly is being lowered in the tubing.

When the assembly has been lowered to the desired depth the valve controlling the flow of fluid through the string of tubing is opened, thereby permitting a flow of fluid to start through the tubing. This upward flow of fluid through the tubing raises the mandrel 11 and causes the frusto-conical section 18 thereof to expand the securing element 20, until the slip elements 21 thereof are firmly set in gripping contact with the inner wall of the tubing, thus preventing further upward movement of the obstructing device 10, the packing cups 40 at the same time being expanded into sealing contact with the inner surface of the string of tubing, thereby preventing passage of the fluid around the obstructing device 10.

If the obstructing device 10 is being used as a tubing seal or plug, the check valve or ball 55 is used as indicated in Fig. 4 and this ball will be raised by the upward flow of fluid through the tubing into sealing contact with the valve seat 52, thus preventing a flow of fluid through the bore 12 of the mandrel 11.

If the device is being used as a plug, the pressure above the assembly is then permitted to escape immediately after the plug becomes effective to stop the flow of fluid in the string of tubing, whereafter the soft metal connecting plugs 70, by which the setting tool 65 is attached to the carrier 28, may be sheared by a relative movement between the outer slip section 77 of the jarring device 75 and the inner section 76 thereof, the lower surface of the said outer slip section 77 striking a hammer blow or blows against the upper surface of the internal flange of the setting tool 65, to cause the said cylindrical body section of the setting tool to move downwardly with respect to the flange 30 of the carrier 28, to shear completely the attachment plugs 70, there being sufficient clearance between the lower edge of the setting tool 65 and the upper surface of the annular flange 26 of the carrier 28 to permit of the said relative movement between the cylindrical body section of the setting tool 65 and the annular flange 30 of the carrier 28.

The downward hammering of the outer section 77 of the jarring device 75 tends to tighten the hold of the slip elements 21 on the inner surface of the tubing by the tendency to drive the said elements downwardly on the tapering surface of the frusto-conical surface 18 of the mandrel 11.

The shearing of the attachment plugs 70 in this case, as in the case above described, may be effected by an upward jarring movement of the jarring device 75, in which case the firm gripping contact of the slip elements 21 with the inner surface of the tubing will be sufficient to prevent loosening of the said elements when the jarring device is moved upwardly to shear the attachment pins 70, connecting the carrier 28 with the setting tool 65.

The jarring device and the setting tool, after shearing of the attachment plugs 70, are then removed from the string of tubing 2, after which the string of tubing itself may by proper manipulation of the control heads and other grouped equipment connected with the well casing and the string of tubing in the manner noted in the said copending application may be completely removed from the casing 1 or the position of the string of tubing with respect to the casing 1 may be varied to any desired extent.

If the obstructing device 10 is to be used as a choke for the string of tubing the check valve 55 and the carrier 10 thereof are eliminated, as indicated in Fig. 5.

When setting the obstructing device, for use as a choke, the assembly is introduced into the string of tubing, in the manner above noted, and, when the desired depth is reached, a momentary flow of the well pressure through the tubing is permitted, just long enough to effect the setting of the packing cups 40 against the inner wall of the tubing, to effect a seal therebetween, and at the same time to effect an upward movement of the mandrel, whereby the slip elements 21 will be expanded against the inner wall of the tubing tightly enough to prevent jerking of the slip elements 21 out of holding contact with the inner wall of the tubing by the shearing of the connecting plugs 70, which is accomplished by the upward jarring movement of the jarring device 75, as above noted.

During the said momentary flow, the fluid will pass upwardly through the bore 12 of the mandrel and the jarring device 75, escaping from the top of the jarring device around the bail 95 carried in the bore of the cap section 90 of said jarring device.

The shearing of the connecting plug 70 is then effected and the setting tool and jarring device removed from the string of tubing in the manner above noted. After removal of the jarring device and setting tool, flow of fluid through the tubing and the obstructing device 10 may be permitted for normal operation of the well.

When it is desired to remove the obstructing device from the tubing, when the obstructing device is being used as a choke, as for the purpose of replacing the choke for one of either larger or smaller diameter, a pulling tool 110 is applied to the inner section 76 of the jarring device 75, in place of the setting tool previously attached thereto, the pulling tool 110 being applied to the telescopic element 76 in the manner indicated in Fig. 6. The assembled unit comprising the jarring device 75 and the pulling tool 110 are then lowered into the string of tubing, in the same manner as the previously inserted unit, as described above.

The pulling tool 110 comprises a head 111 having a suitably threaded axially aligned opening for the reception of the lower threaded end of the internal element 76 of the jarring device 75.

Depending from the head 111 of the pulling tool is provided with a hollow cylindrical body element 112, having parallel longitudinally extending saw-cuts 113, 113, which form in the lower end of the pulling tool a plurality of hook elements 114, 114. In order to make the hook elements 114 resilient, the outer portion of those parts of the body element 112 of which the hook elements 114 are composed is milled out, as indicated at 115.

The hook elements 114 are each provided with an inwardly extending shoulder 116 radially inclined for the purpose of hooking under the radially inclined shoulder 31 of the slip carrier 28, as will be hereinafter described.

The extreme lower ends of the hooks 114 are also inclined radially as indicated at 117 and the segmental portions of the body section 112 lying intermediate the hooks 114 circumferentially of the body element 112 are beveled as indicated at 118. These intermediate segmental sections are stiffened longitudinally by the means of ribs 119, 119 shown clearly in Fig. 7.

Assuming that the obstructing device 10 is being used as a choke, as indicated in Fig. 5, and that it is desired to withdraw the device from the tubing for the purpose of replacing the choke bushing 50 with one of a different inside diameter, the assembled unit, including the jarring device 75 and pulling tool 110, is inserted in the manner described above, the assembly being lowered through the string of tubing on the wire 100 until the elements assume the position shown in Fig. 6, the beveled lower end of the pulling tool 110 passing downwardly around the upper collared end of the mandrel 11, thence downwardly over the annular flange 30 of the slip carrier 28 until the underside of the head 111 of the pulling tool rests on the upper surface of the collar 15 of the mandrel 11; and the lower surface of the annular element 86 of the jarring device 75 rests on the upper surface of the head 111, of the pulling tool 110. As shown in Fig. 6, the hook shoulders 116 at such time are disposed some distance below the undercut shoulder 31 of the slip carrier 28.

In order to release the obstructing device from the tubing 2 the wire 100 is raised, which raises the outer sleeve section 77 of the jarring device 75 accordingly, lifting the lower end of said sleeve from the upper surface of the pulling tool. Sudden release of the pulling wire 100 will permit the outer sleeve section 77 to drop and thereby strike a hammer blow on the head of the pulling tool 110, which is transmitted to the upper end of the mandrel 11. The mandrel 11 in this manner is driven downwardly with respect to the slip elements 21, driving the tapered surface of the frusto-conical section 18 of the mandrel 11 downwardly through the gripping element 20, thereby permitting said element to contract through the action of the spring tongues 24, thus releasing the slip elements 21 from the inner surface of the string of tubing 2. When this takes place the whole device drops within the string of tubing, the undercut shoulder 31 of the slip carrier 28 coming to rest on the radially inclined surfaces 116 of the hooks 114 of the pulling tool 110, the mandrel 11 dropping within the slip carrier 28 until the lower beveled surface 16 of the collar 15 on the upper end of the mandrel rests on the beveled surface 33 at the upper end of the slip carrier 28. The device may then be raised through the string of tubing in the manner indicated in Fig. 3.

During this pulling operation, when the device is used as a choke, flow of pressure through the string of tubing is arrested by closing the control valves at the upper end of the string of tubing, thus the pressure within the string of tubing is equalized above and below the obstructing device, permitting the free hammering movement of the outer sleeve section of the jarring device and the dropping of the mandrel through the slip carrier under the influence of the hammering action set up by the said jarring device.

When the device has been used as a plug, in the manner indicated in Fig. 4, obviously the pressure below the obstructing device is that of the natural pressure in the well, while the pressure in the string of tubing above the obstructing device is considerably less, and probably atmospheric. It is, therefore, necessary before commencing the hammering operation by the jarring device to produce a pressure in the string of tubing above the obstructing device which will be substantially the same as the well pressure below the obstructing device. This may be accomplished by one of a number of different ways, such, for example, as by bi-passing well pressure from the casing head into the top of the tubing above the plug formed by the obstructing device 10, or by introducing, in the upper end of the string of tubing, a column of either oil or water which will be of sufficient height in the tubing above the plug to equalize the well pressure exerted on the underside of the plug valve 55, or by a combination of both methods noted. Obviously, any excess pressure introduced above the plug will pass downwardly through the ball check valve 55 until the pressures above and below the plug are substantially equalized. After equalization of the pressure above and below the obstructing device, within the string of tubing, h been accomplished, the jarring loose of obstructing device may be carried out in manner above noted.

The loosened obstructing device may then be raised to the surface and removed from the tubing by the handling apparatus above referred to.

As an example of the efficiency of the apparatus described as constituting the subject of the present invention, it will be noted that an obstructing device of the nature described has been successfully used as a plug in a well operating at a pressure of 1750 lbs. per sq. in., and held a perfect seal for a period of seventy-two hours, after which the plug was removed in a few minutes by the apparatus and method above described.

If desired the obstructive device may be provided with braking means, such, for example, as that shown in Fig. 12, to prevent the device from moving downwardly in the tubing under its own weight should the gripping element 20, for any reason, be released from gripping contact with the inside of the tubing when the pressure in the tubing above and below the obstructive device is substantially equal.

The braking means, in the present instance, comprises a plurality of shoes 130 spaced circumferentially of the carrier 28, intermediate the elements 24 which operatively connect the slip segments 21 to the lower flange 27 of the carrier 28. The shoes 130 are spring pressed radially outward into frictional contact with the inside of the tubing 2. In the present instance the shoes and their resilient pressing means are one and the same, each shoe 130 forming one part of a flat spring 131, the opposite ends 132 and 133 of which are disposed at an angle to the vertically extending shoe portion 130. The upper end 132 of the spring 132 is seated in a socket or groove 133 formed in the lower flange 27 of the carrier 28 and is held therein and thereto by a screw 134 between the head of which and the spring is a flat sided washer 135, the flat sides of which engage the side walls of the socket groove 134 and prevent the washer from turning.

When lowering the device into the string of tubing when the braking elements 130 are used the jarring device 75 is permitted to rest on the upper end of the obstructive device and the added weight of the jarring device is sufficient to overcome the braking action of the shoes 130, thus the whole assembly will descend within the tubing.

In Figs. 13 and 14, a modified form of connecting means between the slip segments 21 and the carrier 28 is illustrated. This arrangement comprises a rod 24$^a$ which preferably is not of a spring character but may be of cold rolled or other suitable tough but not brittle material. The upper end of the rod 24$^a$ is reduced as at 26$^a$, and a circular flat head 136 formed on the upper end of the reduced portion. The carrier is drilled as at 137 to receive the head 136, the bore 137 being of a relatively larger diameter than the diameter of the head 136.

A slot 138 is provided in the lower wall of the bore 137, and extends to the under side of the flange 27 of the carrier, to receive the reduced portion 26$^a$ of the rod 24$^a$. The slot 138 does not extend to the outer peripheral surface of the flange 27, a portion 139 being permitted to remain to keep the rod head 136 from moving out of the bore 137.

This arrangement permits radial movement of the slip segment 21 and its connecting rod 24$^a$ to a predetermined extent, and permits radial swinging movement of the slip segment, the head 136 rocking in the bore 137.

Lateral swinging movement of the slip segments 21, however, is prevented by the reduced portions 26$^a$ of the rods 24$^a$ contacting with the side walls of the slots 138.

If desired the bores 137 may be radially inclined so that the rod heads 136 will, at all times, during the raising and lowering of the device, when the slip segments are not in gripping contact with the tubing, move radially inward toward the mandrel and thereby cause the slip segments to move correspondingly so that the slip segments will not contact with the tubing during the raising or lowering of the obstructive device in the tubing.

I claim:

1. In a well tool comprising an obstructive device adapted to be placed in the tubing of a well, the combination of a mandrel including a frusto-conical section and an integral axially aligned cylindrical section, an expansible gripping element slidable longitudinally on said conical section, a carrier slidable longitudinally on said cylindrical section, means operatively connecting said carrier and said expansible element, said gripping element being adapted under relative longitudinal movement between the mandrel and said carrier to be expanded by said conical section into gripping contact with the inner surface of the well tubing, packing means between the mandrel and the said inner surface of the tubing to prevent passage of fluid through the tubing around the outside of said obstructive device, said mandrel having a longitudinally extending opening for permitting a flow of fluid through said obstructive device, and a bushing removably disposed in the longitudinal opening of the mandrel and having a bore of smaller area than and communicating with said opening for restricting the flow of fluid through said longitudinal opening.

2. In a well tool comprising an obstructive device adapted to be placed in the tubing of

a well, the combination of a mandrel including a frusto-conical section and an integral axially aligned cylindrical section, an expansible gripping element slidable longitudinally on said conical section, a carrier slidable longitudinally on said cylindrical section, means operatively connecting said carrier and said expansible element, said gripping element being adapted under relative longitudinal movement between the mandrel and said carrier to be expanded by said conical section into gripping contact with the inner surface of the well tubing, packing means between the mandrel and the said inner surface of the tubing to prevent passage of fluid through the tubing around the ortside of said obstructive device, said mandrel having a longitudinally extending opening for permitting a flow of fluid through said obstructive device, a bushing mounted in one end of the longitudinal opening in the mandrel and having a valve seat formed therein, a valve adapted to be seated on said valve seat, and a cap on said mandrel maintaining said valve in operative relation to said seat.

3. In a well tool comprising an obstructive device adapted to be placed in the tubing of a well, the combination of a mandrel including a frusto-conical section and an integral axially aligned cylindrical section, an expansible gripping element slidable longitudinally on said conical section, a carrier slidable longitudinally on said cylindrical section, means operatively connecting said carrier and said expansible element, said gripping element being adapted under relative longitudinal movement between the mandrel and said carrier to be expanded by said conical section into gripping contact with the inner surface of the well tubing, packing means between the mandrel and the said inner surface of the tubing to prevent passage of fluid through the tubing around the outside of said obstructive device, said mandrel having a longitudinally extending opening for permitting a flow of fluid through said obstructive device, said mandrel having a series of transverse openings adjacent the carrier-supporting end thereof, said carrier having a series of transverse openings above the resilient elements carried thereby, a setting tool comprising a cylindrical body adapted to pass over the said transversely apertured portions of said mandrel and said carrier, said cylindrical body having a series of transverse openings adapted to register respectively with the openings of one of the previously said series of openings, and a series of shear plugs passing respectively through the openings of said body into the series of openings registering therewith for operatively connecting the said setting tool to the obstructive device.

4. In a well tool comprising an obstructive device adapted to be placed in the tubing of a well, the combination of a mandrel including a frusto-conical section and an integral axially aligned cylindrical section, an expansible gripping element slidable longitudinally on said conical section, a carrier slidable longitudinally on said cylindrical section, means operatively connecting said carrier and said expansible element, said gripping element being adapted under relative longitudinal movement between the mandrel and said carrier to be expanded by said conical section into gripping contact with the inner surface of the well tubing, packing means between the mandrel and the said inner surface of the tubing to prevent passage of fluid through the tubing around the outside of said obstructive device, said mandrel having a longitudinally extending opening for permitting a flow of fluid through said obstructive device, said mandrel having a series of transverse openings adjacent the carrier-supporting end thereof, said carrier having a series of transverse openings above the resilient elements carried thereby, a setting tool comprising a cylindrical body adapted to pass over the said transversely apertured portions of said mandrel and said carrier, said cylindrical body having a series of transverse openings adapted to register respectively with the openings of one of the previously said series of openings, a series of shear plugs passing respectively through the openings of said body into the series of openings registering therewith for operatively connecting the said setting tool to the obstructive device, and a jarring device operatively connected to said setting tool for effecting the shearing of said connecting plugs.

5. In a well tool comprising an obstructive device adapted to be placed in the tubing of a well, the combination of a mandrel including a frusto-conical section and an integral axially aligned cylindrical section, an expansible gripping element slidable longitudinally on said conical section, a carrier slidable longitudinally on said cylindrical section, means operatively connecting said carrier and said expansible element, said gripping element being adapted under relative longitudinal movement between the mandrel and said carrier to be expanded by said conical section into gripping contact with the inner surface of the well tubing, packing means between the mandrel and the said inner surface of the tubing to prevent passage of fluid through the tubing around the outside of said obstructive device, said mandrel having a longitudinally extending opening for permitting a flow of flu
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hook elements depending from said head around said carrier, shoulders on said hook elements below the shoulder on the carrier, and a jarring device adapted to deliver a hammer blow to said mandrel, to loosen said gripping element from the inner surface of said tubing whereby the shoulders on the hook elements will engage the shoulder of the carrier to support the obstructive device.

6. An obstructive device for well tubing, comprising a mandrel having a longitudinal bore extending from end to end thereof, a cylindrical section adjacent each of the respective ends of said mandrel, a frusto-conical section intermediate said cylindrical sections, an expansible gripping element on said frusto-conical section, a carrier on one of said cylindrical sections, means operatively connecting said carrier with said expansible gripping element, a collar on the carrier-supporting cylindrical section for retaining said carrier on said cylindrical section, packing means carried by the other of said cylindrical sections, and a bushing threaded into one end of said through bore and having a bore of relatively smaller diameter than the said through bore of the mandrel.

7. An obstructive device for well tubing, comprising a mandrel having a longitudinal bore extending from end to end thereof, a cylindrical section adjacent each of the respective ends of said mandrel, a frusto-conical section intermediate said cylindrical sections, an expansible gripping element on said frusto-conical section, a carrier on one of said cylindrical sections, means operatively connecting said carrier with said expansible gripping element, a collar on the carrier-supporting cylindrical section for retaining said carrier on said cylindrical section, packing means carried by the other of said cylindrical sections, a bushing threaded into one end of said through bore and having a bore of relatively smaller diameter than the said through bore of the mandrel, a ball valve adapted to be seated in the lower end of the bore of said bushing, and an apertured cap on the said mandrel providing a chamber for said ball valve.

8. An obstructive device for use within the bore of a flow string of tubing in a well, said device comprising a mandrel freely movable within and with respect to said tubing and comprising a frusto-conical section arranged with the smaller end thereof uppermost, a cylindrical section formed integral with and projecting upwardly from the said smaller end of said frusto-conical section, radially expansible gripping means freely movable on and longitudinally of said frusto-conical section, a carrier for and operatively connected to said gripping means and freely slidably mounted on said cylindrical section, and radially expansible packing means on said mandrel below said gripping means and arranged to be expanded into sealing contact with the inner surface of the tubing and to move said mandrel upwardly with respect to said gripping means to expand the same into gripping contact with the inner surface of the tubing by fluid pressure trapped in the string of tubing by and below said obstructive device said mandrel having a longitudinal bore therethrough and a bushing having threaded engagement with the lower end of said bore, said bushing having a bore of relatively small diameter as compared to the bore of the mandrel.

9. An obstructive device for use within the bore of a flow string of tubing in a well, said device comprising a mandrel freely movable within and with respect to said tubing and comprising a frusto-conical section arranged with the smaller end thereof uppermost, a cylindrical section formed integral with and projecting upwardly from the said smaller end of said frusto-conical section, radially expansible gripping means freely movable on and longitudinally of said frusto-conical section, a carrier for and operatively connected to said gripping means and freely slidably mounted on said cylindrical section, means on the upper end of said cylindrical section for limiting the upward movement of said carrier on said cylindrical section, and radially expansible packing means on said mandrel below said gripping means and arranged to be expanded into sealing contact with the inner surface of the tubing and to move said mandrel upwardly with respect to said gripping means to expand the same into gripping contact with the inner surface of the tubing by fluid pressure trapped in the string of tubing by and below said obstructive device said mandrel having a longitudinal bore therethrough and a bushing having threaded engagement with the lower end of said bore, said bushing having a bore of relatively small diameter as compared to the bore of the mandrel.

10. An obstructive device for use within the bore of a flow string of tubing in a well, said device comprising a mandrel freely movable within and with respect to said tubing and comprising a frusto-conical section arranged with the smaller end thereof uppermost, a cylindrical section formed integral with and projecting upwardly from the said smaller end of said frusto-conical section, radially expansible gripping means freely movable on and longitudinally of said frusto-conical section, a carrier for and operatively connected to said gripping means and freely slidably mounted on said cylindrical section, means on the upper end of said cylindrical section for limiting the upward movement of said carrier on said

cylindrical section, a second cylindrical section formed integral with and projecting downwardly from the larger end of said frusto-conical section, and radially expansible packing means rigidly secured on the said lower cylindrical section of said mandrel below said gripping means and arranged to be expanded into sealing contact with the inner surface of the tubing and to move said mandrel upwardly with respect to said gripping means to expand the same into gripping contact with the inner surface of the tubing by fluid pressure trapped in the string of tubing by and below said obstructive device said mandrel having a longitudinal bore therethrough and a bushing having threaded engagement with the lower end of said bore, said bushing having a bore of relatively small diameter as compared to the bore of the mandrel.

11. An obstructive device for use within the bore of a flow string of tubing in a well, said device comprising a mandrel freely movable within and with respect to said tubing and comprising a frusto-conical section arranged with the smaller end thereof uppermost, a cylindrical section formed integral with and projecting upwardly from the said smaller end of said frusto-conical section, radially expansible gripping means freely movable on and longitudinally of said frusto-conical section, a carrier for and operatively connected to said gripping means and freely slidably mounted on said cylindrical section, means on the upper end of said cylindrical section for limiting the upward movement of said carrier on said cylindrical section, a second cylindrical section formed integral with and projecting downwardly from the larger end of said frusto-conical section, and radially expansible packing means rigidly secured on the said lower cylindrical section of said mandrel below said gripping means and arranged to be expanded into sealing contact with the inner surface of the tubing and to move said mandrel upwardly with respect to said gripping means to expand the same into gripping contact with the inner surface of the tubing by fluid pressure trapped in the string of tubing by and below said obstructive device, said packing means comprising a plurality of relatively spaced cup washers having annular flanges projecting downwardly for trapping said fluid pressure therebelow said mandrel having a longitudinal bore therethrough and a bushing having threaded engagement with the lower end of said bore, said bushing having a bore of relatively small diameter as compared to the bore of the mandrel.

12. An obstructive device for use within the bore of a flow string of tubing in a well, said device comprising a mandrel freely movable within and with respect to said tubing and comprising a frusto-conical section arranged with the smaller end thereof uppermost, a cylindrical section formed integral with and projecting upwardly from the said smaller end of said frusto-conical section, radially expansible gripping means freely movable on and longitudinally of said frusto-conical section, said gripping means comprising a plurality of segmental sections, a carrier freely slidably mounted on said cylindrical section, means for operatively connecting each of said segments to said carrier, means on the upper end of said cylindrical section for limiting the upward movement of said carrier on said cylindrical section, and radially expansible packing means on said mandrel below said gripping means and arranged to be expanded into sealing contact with the inner surface of the tubing and to move said mandrel upwardly with respect to said gripping means to expand the same into gripping contact with the inner surface of the tubing by fluid pressure trapped in the string of tubing by and below said obstructive device said mandrel having a longitudinal bore therethrough and a bushing having threaded engagement with the lower end of said bore, said bushing having a bore of relatively small diameter as compared to the bore of the mandrel.

13. An obstructive device for use in well tubing, said obstructive device comprising a mandrel having sealing means, slips associated with said mandrel and expanded for engagement with the tubing by relative movement of the mandrel with relation thereto, and means for positioning the mandrel in the well tubing comprising a jarring device and frangible means operatively connecting the jarring device and mandrel.

14. An obstructive device for use in well tubing, said obstructive device comprising a mandrel having sealing means, slips associated with said mandrel and expanded for engagement with the tubing by relative movement of the mandrel with relation thereto, and means for positioning the mandrel in the well tubing comprising a jarring device and frangible means operatively connecting the jarring device and mandrel, the frangible means directly engaging the mandrel.

15. An obstructive device for use in well tubing said obstructive device comprising a mandrel having sealing means, slips associated with said mandrel and expanded for engagement with the tubing by relative movement of the mandrel with relation thereto, and means for positioning the mandrel in the well tubing comprising a jarring device and frangible means operatively connecting the jarring device and mandrel, the frangible means being connected with the slips.

HERBERT C. OTIS.

# No. 10,683

## BRIEF FOR APPELLANT

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In The

# United States Court of Appeals

For the District of Columbia Circuit

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Herbert C. Otis, *Appellant*,

vs.

John A. Marzall, Commissioner of Patents, *Appellee*.

United States Court of
For the
District of Columbia
FILED AUG 10 1950
Joseph W. Stewart
CLERK

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**Appeal from a Judgment of the United States District Court for the District of Columbia**

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No. 10,683

## APPELLANT'S QUESTION PRESENTED

Should a Patent Office Board of Appeals decision rejecting combination claims on two prior patents taken together and rejecting sub-combination claims on the patent used as the secondary reference against the combination, be reversed, where, as to the basic reference, the Board found that it does not show the combination claimed and the undisputed evidence before the District Court shows that the structure of the basic reference was based on a different principle of operation from Appellant's device, was believed by Appellant's expert witness to be inoperative and was tried extensively and unsuccessfully by its inventors and abandoned; and where, as to the secondary reference the District Court made inconsistent findings as to its operation, and the undisputed testimony and the patent itself, as well as a part of said inconsistent findings, show an operation of the reference device different from that which the District Court found for the Appellant's sub-combination? The errors below stem mainly from the failure of the Patent Office Board of Appeals and the District Court to understand the nature and operation of the reference devices.

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# United States Court of Appeals

FOR THE DISTRICT OF COLUMBIA CIRCUIT

No. 10,683

HERBERT C. OTIS, *Appellant*,

VS.

JOHN A. MARZALL, Commissioner of Patents, *Appellee.*

**Appeal from a Judgment of the United States District Court for the District of Columbia**

## BRIEF FOR APPELLANT

## JURISDICTIONAL STATEMENT

This is an appeal from a final decree of the United States District Court for the District of Columbia.

Jurisdiction of that Court was based on the Act of August 5, 1939, c. 451, sec. 4, 53 Stat. 1212, U. S. C., Title 35, sec. 63, and the Act of March 3, 1911, c. 231, sec. 24, par. 7, 36 Stat. 1092, U. S. C., Title 28, sec. 41. This Court has jurisdiction under the Act of June 25, 1948, c. 646, 62 Stat. 929, U. S. C., Title 28, sec. 1291.

The Complaint (Joint App. pp. 2A, 3A, 4A) in paragraph 4 recites that the Appellant here, with John C. Luccous, as co-inventor, on January 28, 1943, duly filed an application for patent in the U. S. Patent Office entitled "WELL FLOW REGULATING APPARATUS", which was given Ser. No. 473,838, the undivided interest of the said John C. Luccous being assigned to the Appellant. In paragraph 6 the Complaint shows that the application was finally rejected by the Primary Examiner as to all of its claims, being claims 36 through 66, on July 2, 1946. The Complaint in paragraphs 7, 8 and 9 shows that Appellant appealed to the Board of Appeals from the rejection of claims 36, 38 through 41, 44, 46, 48 through 57, 59 through 62, 65 and 66; that the Board of Appeals on July 23, 1947 reversed the Examiner as to claims 38 and 51 through 55 but sustained the Examiner's rejection as to claims 36, 39 through 41, 44, 46, 48 through 50, 56, 57, 59 through 62, 65 and 66, and on December 8, 1947 refused to change its said action. Paragraph 3 of the Complaint shows that no appeal to the United States Court of Customs and Patent Appeals had been taken. The Complaint was filed on January 19, 1948 (Joint App. p. 4A).

These facts were admitted in the Answer. (Joint App. p. 12A).

The District Court, on March 7, 1950, entered final judgment (Joint App. p. 19A) dismissing the Complaint. Notice of Appeal from said final judgment to this Court was filed by Appellant in the Court below on May 5, 1950. (Joint App. p. 19A.)

## STATEMENT OF THE CASE

The Appellant is seeking a patent on an application S. N. 473,838, filed by him and his assignor John C. Luccous as joint inventors on January 28, 1943, covering an invention entitled "Well Flow Regulating Apparatus."

This application is a continuation in part of two applications; S. N. 329,064, filed April 11, 1940, and S. N. 288,004, filed August 2, 1939. (Plaintiff's Exhibit 1, page 1).

### The Problem and Its History

The invention disclosed in this application and claimed in the claims on appeal has for its purpose the improved control of high pressure wells, particularly oil and gas wells, (Joint App. p. 141A). The production of oil and gas wells did not give rise to any great problems until high pressures were encountered. With the advent of deeper and deeper drilling the pressures mounted and at the present time high pressure wells of 8,000 lbs. per square inch are common. These pressures are encountered in the deeper wells which at the present time commonly exced two miles in depth. (Potter, Joint App. p. 29A). The pipe lines for gathering and distributing the oil and gas products usually operate at pressures between 500 lbs. per square inch and 1200 lbs. per square inch. (Miller, Joint App. p. 83A). Where the well pressure exceeds the gathering line pressure by more than 1,000 lbs. per square inch, this pressure reduction cannot be obtained by use of the customary choke without the danger of freezing. (Miller, Joint App. p. 84A.)

It is with this problem of freezing that this invention is concerned. Freezing in conjunction with high pressure wells has confronted the industry since 1910 (Affidavit of Knode, Plaintiff's Exhibit 1, Joint App. p. 151A), which was the earliest date any witness or affiant had sufficient knowledge of the industry to have known of it. The problem was ever increasing with the advent of higher pressures. (Joint App. p. 22A).

Previous attempts to deal with this problem have been:

> (1) the use of a choke, which frequently was variable, at the earth's surface for throttling flow to control the rate of flow and reduce the pressures, in com-

bination with the use of heaters for applying heat to the exterior of the flow line at and adjacent the surface chokes. The function of the heaters was to provide sufficient heat to the expanding gas to prevent freezing. (Joint App. pp. 23A, 45A, 84A, 85A).

The heaters were objectionable due to their expense, both to install and operate, and due to the danger which accompanied their use. (Joint App. pp. 24A, 25A, 45A, 46A).

(2) The use of a siphon, which is a very small diameter tubing, as the production tubing for the well. The small diameter of the siphon served to restrict flow and reduce the pressures down in the earth where the earth's temperature was high enough to prevent freezing. The siphon was objectionable because it permitted flow of the well only at one rate. (Joint App. pp. 22A, 23A).

(3) The use down in the well of a fixed size removable bottom hole choke or orifice, invented by Appellant (Otis patent 1,920,103, one of the patents relied on by the Patent Office), which was objectionable because it limited the well to one rate of flow (Joint App. pp. 46A, 85A). This bottom hole choke had the advantage of being removable and replaceable with a different size choke to permit a different rate of flow without removing the flow tubing. However, such removal and replacement required extensive operations while the well was shut in. (Findings of District Court No. 5, Joint App. p. 18A).

(4) The proposed use down in the well of a variable choke (set forth in the Knowlton et al patent No. 1,905,592, the basic reference) for the same purpose as the Otis bottom hole choke, but instead of being removable, being connected by means of movable flow tubing to the surface so that by raising and lowering of the flow tubing the size of the bottom hole choke or orifice could be changed to vary rate of well flow. (Joint App. pp. 26A, 27A).

All of the above were used commercially (Joint App. pp. 22A, 23A) except the last which was tried extensively by its inventors for Phillips Petroleum Co., its owner (Joint App. pp. 110A, 111A, 116A, 118A, 119A); found by them on such trials to be inoperative; (Joint App. pp.

113A, 114A, 123A) and junked at the end of the trials as testified on deposition under subpoena by the patentee Knowlton. (Joint App. pp. 119A, 120A). The details of this testimony are discussed more fully hereinafter under "The Knowlton et al Patent No. 1,905,592."

## The Solution Provided by This Invention

It is noted that all the attempts which took advantage of the earth's heat to prevent freezing, employed, down in the well, a means which would limit the flow from the well and none had the concept of reducing pressure down in the well by a constant amount without limiting flow, and independently of rate of flow. By contrast, the concept of this invention is to take advantage of the earth's heat to avoid freezing *by employing in the well a device which will not limit the flow but will effect a predetermined pressure reduction without regard to rate of flow.* The rate of flow is then regulated solely at the surface of the earth in the same manner as in a low pressure well. In other words, the pressure is regulated down in the well and the rate of flow is controlled entirely at the surface of the earth.

This invention has been accepted and put into widespread use by the industry (Joint App. pp. 63A, 64A and Plaintiff's Exhibit No. 6), because the apparatus of this invention makes it possible to produce today's high pressure wells as though they were yesterday's low pressure wells. (Joint App. p. 49A). The chief advantages of this invention in connection with such wells are:

(1) The production of fluid from high pressure wells at varying rates of flow with the same and only the same manipulation of surface controls as employed in producing low pressure wells (Joint App. pp. 48A, 49A);

(2) The elimination of high pressures within the flow tubing near the surface of the earth and within the well connections at the surface of the earth, re-

ducing the likelihood of a blowout (Joint App. pp. 49A, 93A);

(3) The creation and maintenance of a low pressure condition at the outlets of wells which permits them to be connected directly to a gathering system operated at a pressure much lower than the well formation pressure and to supply fluid to such system at a greater or lesser rate depending upon requirements of the system and without necessity of individual manual control of the individual wells. (Joint App. pp. 34A, 66A) and

(4) The reduction of pressure within well fittings at the surface of the earth to any desired degree, even to atmospheric pressure if desired, thereby making it possible to remove all control equipment from the tops of wells for repair, alteration or replacement. (Joint App. pp. 65A, 66A, 93A).

The invention comprises the combination with the customary variable choke or control valve at the top of a well of a pressure reduction regulator located down in the well at a depth usually 3000 feet or more (Joint App. p. 26A) where the natural earth temperatures exist up to and even above 254° F. (Joint App. p. 29A) and supply heat to prevent the freezing referred to (Joint App. p. 29A). The regulator is automatically responsive to adjustments of the surface choke (Bd. App. Dec., Joint App. p. 147A) to permit the flow of fluid proportional to the opening of the surface choke while creating and maintaining a substantially constant predetermined pressure reduction between a point just below the regulator and a point just above it (Findings of Dist. Ct. No. 2, Joint App. p. 17A). Reductions in pressure up to 1500 lbs. per square inch are ordinarily accomplished by one regulator (Joint App. pp. 65A, 87A, 88A) in actual field use. In cases where the required pressure reduction is greater than is feasible by one regulator, two or more regulators are employed one above the other, and such regulators are spaced from each other by distances of the order of 1000 feet. (Joint App. pp. 87A, 88A, 93A).

The invention includes also the down-in-the-well pressure reduction regulator as a sub-combination. This sub-combination is essentially a loaded valve comprising a combination of fixed and movable valve elements, and loading means whereby the movable valve element is urged or biased toward closed position and subject to the inlet pressure tending to open it and the outlet pressure tending to close it. Thus the valve will remain closed until the outlet pressure above the valve is less than the inlet pressure below the valve by the amount of the load or bias.

Inasmuch as it is the concept of this invention to control flow from a well at the surface of the earth rather than down in the well, the invention contemplates that the regulator down in the well be a pressure reduction regulator as distinguished from a rate-of-flow regulator. By this expedient the only manual control is readily accessible at the earth's surface and is positive in its action. Pursuant to this concept, Appellant's regulator sub-combination has as its object the maintenance of a substantially constant pressure reduction for all degrees of opening. This is accomplished by a regulator valve in which a special loading means loads the valve with substantially the same load or force when the valve is open to the fullest extent expected, as when it is closed. Such means for applying a substantially constant force to an object throughout its range of movement are not claimed to be novel in themselves, but the sub-combination including this means in combination with the valve elements is claimed to be novel.

The particular constant loading or biasing means disclosed as an example in the patent application is a spring which is relatively long, as compared to the limited movements of the movable valve element between closed and fully open positions, so that such movements of the valve element will cause little variation in the expansive force exerted by the spring. (Ptfs. Ex. 1, p. 28). In the Applicant's actual structure a spring seven inches long is used (Joint App. p.100A), as compared with a total travel of the movable valve element of 1/16th of an inch, or less than one per cent (1%) of the spring length. This full open position allows passage of 5,000,000 cu. ft. of gas per day (Joint App. pp. 99A, 100A).

In order to protect the spring employed in the regulator from erosion due to the presence of abrasive particles in the well fluids flowing through the regulator, a sleeve is used as the movable valve element, and the spring is placed outside the sleeve. The flow is then caused to take place through the inside of the sleeve. (Joint App. pp. 62A, 63A).

In order to prevent leakage around the sleeve which would erode the spring, and to assist in preventing destructive vibration which would occur at higher rates of flow, a pressure sealed packing is provided around this sleeve. (Joint App. p. 73A). The seriousness of the problems of erosion and vibration can hardly be comprehended. However, when it is remembered that the rate of flow through the tiny orifice of the regulator valve approaches and actually exceeds the velocity of sound under common field practice, (Joint App. p. 100A) the magnitude of the problem will be recognized. The testimony establishes that a flow of 3,000,000 cu. ft. per day from a single well is considered good practice (Joint App. pp. 29A, 30A), and that at times of peak withdrawal the rate of flow may be as high as 5,000,000 cu. ft. per day. The meaning of 3,000,000 cu. ft. of gas per day is given as being sufficient gas to supply a city of 12,000, 13,000 or 14,000 population in winter at the latitude of Dallas, Texas (Joint App. p. 30A).

## The Claims

Seventeen (17) claims are involved in this appeal. These are printed in full in the Joint Appendix pp. 4A to 11A, inclusive.

Ten (10) of the claims on appeal, namely, 36, 39, 56, 57, 59, 60, 61, 62, 65 and 66 cover the combination of a choke or control valve at the top of a well with a pressure reduction regulator located down in the well and automatically responsive to adjustments of the surface choke to permit the flow of fluid proportional to the opening of the surface choke while creating and maintaining a substantially constant predetermined pressure reduction between a point just below the regulator and a point just above it. Of these ten claims, claims 65 and 66 specify a plurality of such regulators in the well.

The other seven claims on appeal, Nos. 40, 41, 44, 46, 48, 49 and 50 are drawn to the pressure reduction regulator as a sub-combination. Of these, all except Claim 44 specify the fixed and movable valve members and the means acting on the movable valve element to create and maintain a predetermined pressure differential for varying rates of flow. Claims 46, 48 and 50 additionally provide that the movable element is a sleeve and Claim 48 is quite specific in that it provides that the means acting on the movable valve element is a spring which surrounds the sleeve and that a packing also surrounds the sleeve. Claim 44 calls for the constant pressure reduction regulator as an element in combination with a means for anchoring and sealing it at a desired place in a well tubing. The anchoring means is also in claims 46, 48 and 50.

Six (6) claims were allowed by the Board of Appeals, (Joint App. pp. 147A, 148A, 149A) Nos. 38, 51, 52, 53, 54 and 55, (reproduced in Joint App. pp. 129A, 134A, 135A, 136A), all of which are directed and limited to an auxiliary feature which makes it possible to pump downwardly through the regulator. This feature of the invention has no bearing on the control of the pressure of fluid flowing from a well (Joint App. p. 50A) and, therefore, these allowed claims do not protect the basic invention.

## The Board of Appeals Decision

The Board of Appeals found with regard to the basic reference patent, Knowlton et al, that:

> "We cannot agree with the position taken by the Examiner that the Knowlton et al Patent No. 1,905,592 discloses the combination defined by the appellants in claims 36, 38, 39, 56, 57, 59 through 62, 65 and 66, namely, a surface choke in combination with a bottom hole choke or regulator automatically responsive to the adjustments of the surface choke." (Joint App. p. 147A)

Nevertheless, the Board of Appeals held that in view of Bruce 1,199,152, it would not "involve the exercise of the inventive faculties to substitute, for the manually operated valve or bottom hole choke in the Knowlton et al well control device, an automatic valve of the type disclosed by Bruce." (Joint App. p. 147A) It thereupon affirmed the rejection of the ten (10) combination claims here on appeal on Knowlton et al in view of Bruce.

The Board of Appeals held that "the Bruce patent discloses the valve structure recited in claims 40, 41, 49 and 50;" and affirmed the rejection of these claims on Bruce. (Joint App. p. 148A)

The Board of Appeals held claims 46 and 48 not patentable over Bruce in view of Otis 1,920,103, and affirmed the rejection thereof on that ground and also on the ground that they are met by Bruce without Otis. (Joint App. p. 148A). The Board of Appeals made no comment on the fact that Claim 48 specifies that the spring surrounds the movable valve sleeve and that there is a means for packing off between the sleeve and the body, and that these elements are missing from both Bruce and Otis.

The Board of Appeals held that Claim 44 "is likewise unpatentable over Bruce in view of Otis 1,920,103." (Joint

App. p. 148A) It affirmed the rejection of Claim 44 on this ground.

The Otis Patent 1,920,103 was used in the above rejections solely to illustrate a means for anchoring a flow control device in a well tubing.

## The District Court's Opinion and Findings

The Court below stated that it agreed with the opinion of the Board of Appeals. (Joint App. p. 16A)

The District Court correctly found, with respect to the operation of Appellant's regulator valve sub-combination:

> "* * * The valve mechanism *acts to maintain a constant difference between the pressure immediately above and the pressure immediately below the valve,* regardless of the well pressure or the extent of opening of the manual valve at the surface." (Emphasis ours) (Joint App. p. 17A, paragraph 2)

As to the secondary reference, the Bruce Patent No. 1,199,152, which is also the reference on which the Board of Appeals based its rejection of the Appellant's sub-combination claims, the District Court made inconsistent findings, the following portion of which Appellant urges is erroneous:

> "* * * The arrangement thus provided *serves to maintain a constant differential in pressure* between the inlet and outlet ends of the casing. * * *" (Emphasis ours). (Joint App. p. 17A, paragraph 4)

In the next sentence and with reference to the same Bruce patent valve, the District Court inconsistently but correctly found:

> "* * * The device is shown only in connection with an internal combustion engine for admitting supplementary air from the atmosphere into the intake manifold *in accordance with changes in the degree of vacuum* existing in the intake manifold from time to time * * *." (Emphasis ours) (Joint App. pp. 17A, 18A, paragraph 4.)

It is an axiom of physics that a single valve cannot serve "to maintain a constant differential in pressure . . . in accordance with changes in the degree of vacuum." That is the same as "lifting yourself by your own bootstraps."

### The Knowlton et al Patent 1,905,592

1. The Board of Appeals refused to agree with the Examiner that this patent discloses the combination of the ten combination claims on appeal. (Joint App. p. 147A)

2. The witness Potter, Assistant to the President of the Lone Star Gas Co., one of the larger gas companies, and an engineer of 21 years experience in gas production, (Joint App. pp. 20A, 21A) testified on cross-examination (Joint App. p. 35A) that the size of the opening of the Knowlton et al device at the bottom of the well would be affected by variations in the length of tubing caused by changes in temperature resulting from expansion of gas through the opening and that as a practical matter you could not have the skill necessary to cope with these changes by manual regulation. He stated (Joint App. p. 36A) that "Theoretically it is inoperative as a variable device, as I see it.", and that "The theoretical reason is that it would be impossible to contend at the surface, throughout the tubing string, with variations in temperature that you would encounter when you induced changes in rates of flow."

3. The patentee Knowlton, an engineer of 29 years experience in the oil and gas industry, (Joint App. p. 108A) who, during World War II, was National Director, Production Division, Petroleum Administration for War (Joint App. p. 109A) and at the time of filing the application for patent No. 1,905,592 was Chief Engineer of Phillips Petroleum Co., (Joint App. p. 109A), the owner of this patent, (Joint App. p. 110A) testified on deposition under subpoena (Joint App. p. 108A) that as Chief Engineer he was confronted with the problem of freezing in

Phillips Petroleum Company's gas wells, due to expansion of the gas at the surface (Joint App. p. 124A); that the Phillips Petroleum Co. installed apparatus as shown in Figure 1 of Patent No 1,905,592 in two wells, one in Texas and one in Oklahoma in 1933, and tested the same under Knowlton's supervision (Joint App. p. 110A); that Crites was also present (Joint App. p. 127A); that the test in one well lasted at least four months, and possibly six months (Joint App. p, 111A); that in the other well they replaced the needle several times and that a needle in some instances would last several days or a week (Joint App. p. 118A) and changing needles required a day or two (Joint App. p. 119A); that "The cooling effect of the expansion of the gas apparently or did have a tendency to cool the tubing and have an action of shrinking and contracting the tubing and actually raising the seat off of the stationary needle or valve.", (Joint App. p. 113A); and that that would give a change in the setting of the bottom hole orifice; that in trying to overcome this difficulty of contraction of the tubing they built a number of needles with a 12-inch taper instead of those with a 4-inch taper originally employed (Joint App. p. 114A) but that "* * * we never could determine exactly the size of the opening because of this contraction of the tubing." (Joint App. p. 115A); that the apparatus used in these two wells was disposed of as junk and the wells thereafter produced under ordinary methods (Joint App. pp. 119A, 120A); and that no other installations were ever made (Joint App. p. 121A). Mr. Otis testified that Phillips Petroleum Co. is a regular customer for Appellant's bottom hole regulator involved in this appeal (Joint App. pp. 60A).

4. Knowlton and Crites in Patent No. 1,905,592 approached the freezing problem by trying to control *flow* down in the well and permit whatever pressure reduction resulted from the restricted flow, as distinguished from controlling pressure reduction without regard to flow. (Joint App. p. 27A). *There is nothing in the Knowlton*

*et al patent indicating any intent or possibility of manipulating the bottom hole manual control valve to regulate pressure reduction independently of rate of flow,* (Joint App. pp. 32A, 63A, 74A). On the contrary the Knowlton et al patent says (p. 1, line 5):

> "Such improvements can be used for controlling the flow of any fluid from a well, but they are particularly useful for regulating the flow of oil or gas from a well, either as a means of regulating the amount of oil and gas coming from the formation or as a medium for controlling the gas that is introduced from the surface to provide a gas lift."

Furthermore, the patent states with regard to its mode of operation:

> "* * * By using an adjustable bottom hole bean made in accordance with the invention, the uniform year-round temperature at the bottom of the hole is taken advantage of and *no surface choking is necessary.* By such equipment, we can eliminate the expansion of gas at the surface, which usually results in freezing of equipment." (Emphasis added)

This teaching is contrary to the instant invention that the flow can be controlled at the surface and the pressure reduction regulated beneath the surface independently of the flow.

Knowlton (Joint App. p. 126A), and Potter (Joint App. pp. 26A, 27A), testified with regard to the possibility of regulating flow by the surface choke of the Knowlton et al device that if it were attempted to reduce flow by the surface choke alone the pressure above the bottom hole choke would rise and freezing would be apt to result and that opening of the surface choke would not result in increased flow over that for which the bottom hole choke might be set.

5. Knowlton testified that the bottom hole choke of the Knowlton et al patent could not be staged, i.e., two or more of such chokes employed in a single well, one above

the other, so that one would take part of the pressure reduction and another an additional part of the pressure reduction (Joint App. p. 120A).

## The Bruce Patent 1,199,152

The Bruce patent figured in the rejection of every claim on appeal. This is the secondary reference that figured in the rejection of the combination claims and was the basic reference upon which the sub-combination claims were rejected. Special consideration of this patent by the Court is solicited for it is Appellant's position that the lower Court and Patent Office misunderstood this patent and that this misunderstanding was principally responsible for the errors complained of below.

With reference to the Bruce patent:

1. The District Court found inconsistently that on the one hand (a) it would serve to maintain a *constant differential in pressure* between its inlet and outlet ends, (Joint App. p. 17A) and that on the other hand (b) as the patent itself states, it admits air in response to *changes in vacuum* (which is pressure differential less than atmospheric) (Joint App. pp. 17A, 18A). These findings are inconsistent in that if the device maintained a *constant* differential in pressures, there would be no *changes* in vacuum (pressure less than atmospheric) to which it could respond as the patent requires.

2. The undisputed testimony shows that the valve of the Bruce patent controls the *rate* of flow in response to varying pressure differential and does not regulate pressure differential without regard to flow. (Joint App. pp. 60A, 61A, 106A, 107A). This is the exact opposite of the regulator under consideration.

3. The Bruce patent itself is consistent with the expert testimony and states in effect that the automatic valve shown in the patent regulates the rate of flow in response to changes in the pressure. This is in contrast

to the appellant's pressure reduction regulator wherein a substantially constant pressure differential is maintained throughout changes in the velocity of flow from a condition of no flow to 5,000,000 cu. ft. per day.

The Bruce patent states (beginning p. 1, line 9):

> "The object of my invention is to provide an automatic valve, of simple and cheap construction and of few parts, *whereby the flow of fluids therethrough* (especially those of gaseous form) *may be automatically regulated by the action of the varying pressure exerted by such fluids.* Such valve may be used with advantage as in air-intake for the inlet of the manifold of internal combustion engines, and is shown and described herein as so placed.
>
> "From the drawing and description it will be seen, that my said improved automatic regulating valve, may be used with advantage, *to automatically regulate the flow of all fluids, by the varying pressure,* whether the pressure upon the moving and actuating parts of the valve is varied by increase of pressure upon the inlet side, or diminution of pressure upon the outlet side, of such moving and actuating parts. * * *
>
> "* * * Fig. 3 is a like view showing the same *in the medial or half open position, caused by increased pressure upon the inlet or diminished pressure on the outlet* side, and Fig. 4 is a like view of the positioning of the moving parts, when *upon further increase of exterior or diminuation of interior pressure the valve-disk is forced to the fully open position."* (Emphasis ours)

## STATEMENT OF POINTS

### I.

The District Court erred in not holding the Knowlton et al patent 1,905,592 unavailable as a basic reference against the ten combination claims on appeal because:

A. The District Court by adopting the Board of Appeals decision found that the Knowlton et al patent does not show the claimed combination and there is no other reference, which, taken with the Knowlton et al patent, will teach the claimed combination.

B. The Knowlton et al patent apparatus has been conclusively proven inoperative.

## II.

The District Court erred in holding that the valve of the Bruce Patent No. 1,199,152 functions as does the Appellant's bottom hole regulator because this finding is inconsistent with the Court's true finding that it operates on a different principle and, therefore, erred in not holding the Bruce patent unavailable as a reference against the sub-combination claims and as a secondary reference against the combination claims.

## III.

The District Court erred in failing to find that in view of the long-standing nature of the industry-wide problem solved by this invention covered by the claims on appeal, and the repeated efforts and failures of others to provide a complete solution of the problem, including the complete inoperativeness of the attempted solution disclosed in the principal reference, and in view of the prompt and universal acceptance and widespread use of the Appellant's solution of the problem, the Appellant's solution involves a high standard of patentable invention.

## SUMMARY OF THE ARGUMENT

A. The District Court by approving the Board of Appeals' findings as to the Knowlton et al patent (Joint App. p. 16A), found that the patent does not disclose the general combination of the ten combination claims on appeal (Joint App. p. 147A), and therefore the Court should have held that the Knowlton et al patent was not available as a basic reference. This is true because the Board's finding is to the effect that the Knowlton et al patent teaches a different structure or combination of elements which function differently than do the elements of the claimed combination to give a different overall result. There is no other reference, (and certainly not the Bruce patent) which, when taken with the Knowlton et al patent, will teach the invention as claimed. This is true because the Bruce patent does not show a structure which functions in the same manner to give the same result as the element of the claimed combination which is lacking in the Knowlton et al disclosure and which the Bruce patent is supposed to supply.

The District Court found that the combination claims on appeal called for a surface choke on a well and a bottom hole regulator in a well automatically responsive to the adjustments of the surface choke to maintain a constant reduction down in the well regardless of the adjustment on the surface choke. The District Court, in approving the Board's finding, held that the Knowlton et al patent teaches a combination of elements which are different from those called for by the claims. The District Court further found that the Knowlton et al patent combination will give a different function, namely, to make it possible to obtain within a well a pressure differential "ranging from zero to a maximum formation pressure." (Joint App. p. 17A)

These findings of the Court clearly hold that Appellant's structure works in one way and the Knowlton et al patent structure works in an entirely different way. For this reason, the Knowlton et al patent is not available as a basic reference because the Bruce patent, with which it is combined, does not teach the modification of the Knowlton et al structure so that it would operate in the manner that Appellant's structure operates.

The Knowlton et al patent contains no suggestion that its structure could be used to maintain a constant pressure reduction down in the well but, as found by the Court, teaches to the contrary that the pressure within the well may be varied between zero and the maximum formation pressure. The testimony of the patentee, Knowlton, and the experts establishes that the patented arrangement could not be otherwise operated.

The testimony also shows that the rate of flow in the Knowlton et al patent is regulated solely by the bottom hole choke.

Under these circumstances the Knowlton et al patent does not show the general combination of a surface choke for controlling rate of flow with a bottom hole regulator for maintaining a constant pressure reduction down in the well, and is not available as a basis for building up a combination that would so operate.

B. The Knowlton et al patent structure has been conclusively proven inoperative by the testimony of the patentee Knowlton, who testified on deposition under subpoena, (Joint App. p. 108A) and was in the embarrassing position of having to admit that he and his co-patentee Crites had tried to make their invention work for their employer-assignee, Phillips Petroleum Company, but without success. He further admitted that he had made modifications of the invention in an effort to make it work (Joint App. p. 114A), but that in the end the equipment was junked. (Joint App. pp. 119A, 120A) What stronger proof of inoperativeness could there be than that the inventors themselves, backed by the invention's owner, a large corporation, with a pressing problem to be solved by the invention, were unable to make it work? The final touch is that Knowlton was not merely a skilled mechanic, but was nationally recognized as the Number One expert in his field, (Joint App. p. 109A) and the problem to be solved was his responsibility as Chief Engineer for his employer. (Joint App. p. 124A)

## II.

The District Court found correctly as to the operation of the device on appeal that it maintained a constant pressure reduction down in the well regardless of the adjustment of the surface choke which controls rate of flow from the well, (Joint App. p. 17A) and also found correctly that the Bruce patent valve operates differently in response to changes in vacuum to control flow (Joint App. p. 17A). These findings are more than amply supported by the testimony and by the patent itself.

Inconsistently with its correct finding that the Bruce valve operates in response to *changes in pressure* (vacuum) to control flow, the District Court found that the valve *maintains a constant pressure difference.* (Joint App. p. 17A) If the valve operates in response to changes in pressure, there is not a constant pressure difference and the valve cannot be said to maintain one. If, on the other hand, the valve maintained a constant pressure difference, there would be no changes in pressure and it would not operate to control flow as the patent states it does. The two findings are wholly repugnant to each other and cannot both be true.

The Bruce valve and the regulator of the claims on appeal have two different objects, and accomplish those two different objects by differences in proportions of their parts. The Bruce valve acts to control flow and does this in response to variations in pressure. For this purpose he employs a spring loaded valve in which the spring is so proportioned to the travel of the valve that it will be compressed to less than half its original length when the valve moves from closed to open positions. The regulator on appeal was designed in response to the concept that what was desired was a regulator that would maintain a substantially constant pressure reduction without regard to the rate of flow through it. To accomplish this result, a spring loaded valve was provided employing, by contrast to the Bruce arrangement, a spring which was compressed by less than one per cent (1%) of its length in the movement of the valve from closed to open positions. The two devices sought to do different jobs and their respective inventors proportioned their elements to accomplish the desired results. Neither would serve the purpose of the other and the one does not anticipate the other.

## III.

The problem of freezing encountered in the control of production from high pressure gas wells has existed at least since 1910 (Joint App. 151A). It had been industry-wide and increasing in seriousness. (Joint App. p. 22A) The only solutions the experts in the art had offered and which had been usable at all, had been dangerous or had limited to one rate of flow the operation of wells on which they were employed, and the Knowlton et al attempt, described in the basic reference used against the claims on appeal, was wholly inoperative.

The solution defined and covered by the claims on appeal has achieved immediate and widespread acceptance by the industry as the solution to this problem and is used in 419 different gas fields in the United States and abroad. (Joint App. pp. 63A, 64A) This is a case falling squarely within the doctrine of *Washburn and Moen Manufacturing Co., et al* vs. *The Beat'em All Barbed Wire Company, et al,* 143 U. S. 275, under which the one who takes the last step and achieves success where others failed should be given patent protection.

# ARGUMENT

## I.

A. The District Court found that the structure of the combination claims on appeal functioned in one manner to give one result and then found that the basic reference, Knowlton et al, functioned differently to give a different result. Further, there is no other reference, and certainly not the Bruce patent, on which the patent office relied as the secondary reference, which teaches a modification of the Knowlton et al structure so that its various elements would function to give the result of Appellant's structure. In view of these recognized shortcomings of the Knowlton et al patent, the District Court should have held that it was not available as a basic reference against the ten combination claims on appeal.

More specifically, the District Court found that the combination claims on appeal set forth "a surface choke in combination with a bottom hole choke or regulator automatically responsive to the adjustments of the surface choke" (Board of Appeals Decision adopted by District Court, Joint App. p. 147A) which "acts to maintain a constant difference between the pressure immediately above and the pressure immediately below the valve (the bottom hole regulator), regardless of the well pressure or the extent of opening of the manual valve at the surface" (District Court Findings of Fact, par. 2 Joint App. p. 17A). (Parenthetical interpolation ours)

The District Court found that the Knowlton et al patent No. 1,905,592 "discloses a control system for fluid wells comprising a manually operable valve located in the outlet pipe at the ground level and a second valve, located in the outlet pipe near the bottom of the well and manually controlled from the ground level." The District Court further found with regard to this patent that it states "that the arrangement disclosed 'makes it possible to obtain a pressure differential between the well and the inside of the tubing ranging from zero to the maximum formation pressure'." (District Court Findings of Fact, par. 3 Joint App. p. 17A)

The District Court through adopting the Board of Appeals decision further found that the Knowlton et al patent did not disclose the combination set forth in the ten combination claims on appeal. (Joint App. p. 147A)

Thus, it will be seen that under the findings of the District Court the Knowlton et al patent discloses a different combination from that claimed in the ten combination claims in that it employs a manual bottom hole valve instead of an automatic regulator, and functions in a different manner from the combination claimed in that the manual bottom hole valve of Knowlton is stated by the Knowlton patent to make it possible to obtain a pressure differential between the well and the inside of the tubing ranging from zero to the maximum formation pressure, instead of to maintain a constant difference between the pressure immediately above and the pressure immediately below the valve, regardless of the well pressure, or the extent of the opening of the manual valve at the surface, which is the function of the Appellant's claimed combination.

No other reference of record purports to suggest a valve down in a well which can perform the functions stated. Therefore, even if a valve capable of performing such a function were shown in Bruce or some other prior art of record, (which is denied) it would be improper to substitute it in the Knowlton et al combination for the manual bottom hole choke of Knowlton to build up a new combination in which it would perform a new function neither taught nor possible with the Knowlton et al bottom hole choke.

Therefore, the Knowlton et al patent clearly fails to show the general combination of the ten combination claims on appeal, and for that reason should have been held by the District Court to be unavailable as a basic reference against these combination claims.

In addition to the Court's findings of an entirely different mode of operation for Appellant's bottom hole regulator and the Knowlton et al bottom hole variable choke, the patent itself and the testimony, show that the Knowlton surface valve is only for closing the well and doesn't function to regulate flow. Instead, in the patented combination the flow from the well is controlled entirely by the bottom hole choke as testified by Knowlton (Joint App. p. 126A), and Potter (Joint App. pp. 26A, 27A), and as shown on the face of the patent on page 1, beginning in line 40:

> "By using an adjustable bottom hole bean made in accordance with the invention, the uniform year around temperature at the bottom of the hole is taken advantage of and *no surface choking is necessary.* By such equipment we can eliminate the expansion of gas at the surface, which usually results in freezing of equipment." (Emphasis ours)

The testimony of Knowlton and Potter also clearly proves that the surface choke of Knowlton could not be employed to regulate the rate of flow from the well without danger of freezing.

On the other hand, *in a combination such as set forth in the claims on appeal* in which a constant pressure differential is maintained down in the well without regard to the rate of flow, *the control of flow from the well is effected entirely by regulation of the surface choke.* Thus the elements of the combination of the claims on appeal cooperate in a new way to control flow from the well, such control being effected entirely by a regulating choke at the surface where it is easily accessible and positive in operation, and the difficulties such as temperature drop and the effects thereof, which Knowlton was unable to overcome, are eliminated. No one prior to Appellant has controlled rate of flow from a well entirely by a surface control while disposing of troublesome high pressures down in the well.

In view of the entirely new function and cooperation of elements which is present in the combination of the claims on appeal, and particularly in the absence of any other reference which would teach or suggest the combination, it is respectfully submitted that it would be improper to tear apart and rebuild the Knowlton et al combination and substitute therein parts from the prior art in order to build up this new combination claimed by Appellant.

*Webster Loom Co.* vs. *Higgins,* 105 U. S. 580; *Goodyear Tire & Rubber Co.* vs. *Ray-O-Vac Co.,* 321 U. S. 275 (1944).

B. The inoperativeness of the Knowlton et al patented device is conclusively proven by the testimony of the patentee Knowlton, a disinterested witness giving fact testimony under subpoena with regard to his own efforts to make his own invention work.

Knowlton as one of the inventors worked with Crites, the other inventor, (Joint App. p. 127A) for their employer, Phillips Petroleum Co., the owner of the Knowlton et al patent, in an effort to make their invention work to solve the problems of their employer, which were also the responsibilities of Knowlton as Chief Engineer. (Joint App. p. 124A) A situation could hardly be imagined in which there would be more incentive to make the invention operate.

Not only was the invention as shown in the patent conclusively proven to be inoperative (Joint App. pp. 114A, 115A) but Knowlton testified that changes were made in an effort to make it operate (Joint App. p. 114A). Knowlton was more than a mechanic ordinarily skilled in the art. He was a recognized expert later selected by the Government of the United States as the Number One expert of the country with regard to the production of oil and gas wells, and made National Director of the Production Division of the Petroleum Administration for War (Joint App. p. 109A). Such an expert, with the facilities of the Phillips Petroleum Company at his command, and with every incentive to make his invention work, was unable to do so.

Therefore, not only was the invention proved conclusively to be inoperative, but it was conclusively proved that vastly more than the efforts of a skilled mechanic would be required to make it operative.

The inoperativeness of the Knowlton et al invention as found by Knowlton and Crites in their efforts to make the invention work is supported by the expert testimony of the disinterested witness Potter, an engineer of 21 years experience in the production of gas (Joint App. pp. 20A, 21A), and who in that time had risen from his original work of installing equipment in the field to the position of assistant to the president of the Lone Star Gas Company, and whose company had also had, throughout the witness' experience, the problem of freezing in connection with the production of gas (Joint App. pp. 22A, 24A). Potter testified that in his opinion the Knowlton et al device was theoretically inoperative (Joint App. p. 35A) and stated that the theoretical reason why it was inoperative "is that it would be impossible to contend at the surface, throughout the tubing string, with variations in temperature that you would encounter when you induced changes in rates of flow." This testimony was given on cross-examination.

The reason for the experience of Knowlton and Crites in failing to make their invention work is clearly shown also by the testimony of Schramm, Chief Engineer for Otis Engineering Corp., as to the amount of contraction to be expected in a well tubing in connection with the expansion of gas being produced through the tubing. Without going into the details of Schramm's testimony, it is thought that it will be sufficient to mention that it is within the knowledge of the Court that the expansion of metals under changes in temperature is so substantial that in the laying of railroads it is necessary to leave spaces between the ends of rails to accommodate for this expansion and contraction, and the Court has doubtless observed these spaces visually, and has sensed them audibly and felt their effects in the course of riding on a train.

The rule observed by this Court with regard to the burden of proving inoperativeness of a reference device has been stated by Mr. Justice Edgerton in his opinion in the case of the *Bullard Company et al* vs. *Coe, Com'r of Pat.*, 79 App. D. C. 369, 147 F (2) 568. It is submitted that in this case the Appellant has fully sustained his burden under that rule in proving (1) inoperativeness of the reference device, and (2) that it could not be made operative by slight changes within the skill of a competent mechanic.

As contrasted with the situation in the *Bullard* case, the effort to make the reference device work was in the present instance made by one of its inventors, not in contemplation of proving it inoperative, as in the *Bullard* case, but in a serious and extended effort to put it to actual use to solve a pressing problem, and with every incentive to make it work. It would be hard to conceive of a situation involving more conclusive proof of inoperativeness of an invention and of the fact that it could not be made operative by changes within the skill of a competent mechanic.

It is, therefore, respectfully submitted that the Knowlton et al patent shows a device which is inoperative and which could not be made operative by the skill of an ordinary mechanic, and that it is for that reason unavailable as a basic reference against the combination claims. See *Kelley* vs. *Coe, Com'r. Pat.*, 69 App. D. C. 202, 99 F (2) 435 (1938); *Lombard and Milligan* vs. *Coe, Com'r. Pat.*, 33 Fed. Supp. 440 (D. C. Dist. Col. 1940).

## II.

The District Court made inconsistent findings of fact with regard to the Bruce patent which shows that the Court was confused both as to the structure and the mode of operation of this patent. It will be developed that the patent itself and all of the evidence before the Court supports only that part of the inconsistent finding which recites a structure and mode of operation for Bruce that is contrary to the Court's finding with regard to the structure and mode of operation of the Appellant's regulator. In view of this, it is submitted that the District Court should have held that the Bruce patent was unavailable as a reference.

The District Court incorrectly found that the Bruce valve "serves to maintain a constant differential in pressure between the inlet and outlet ends of the casing" (Joint App. p. 17A). Inconsistent with this finding the Court found correctly that the Bruce valve operates to control the admission of supplementary air into an intake manifold "in accordance with changes in the degree of vacuum existing in the manifold from time to time." (Dist. Ct. findings, par. 4 Joint App. pp. 17A, 18A).

The latter finding by the Court is in accord with the teachings of the patent and with all of the testimony relating to the Bruce valve. In the patent on page 1, beginning with line 9, it is stated:

> "The object of my invention is to provide an automatic valve, of simple and cheap construction and of few parts, whereby the flow of fluids therethrough (especially those of gaseous form) may be *automatically regulated by the action of the varying pressure exerted by such fluids.* Such valve may be used with advantage as in air-intake for the inlet of the manifold of internal combustion engines, and is shown and described herein as so placed.
>
> "From the drawing and description it will be seen, that my said improved automatic regulating valve,

> may be used with advantage, *to automatically regulate the flow of all fluids, by the varying pressure,* whether the pressure upon the moving and actuating parts of the valve is varied by increase of pressure upon the inlet side, or diminution of pressure upon the outlet side, of such moving and actuating parts.
>
> * * * *
>
> ". . . Fig 3 is a like view showing the same in the medial or half open position, *caused by increased pressure upon the inlet or diminished pressure on the outlet side,* and Fig. 4 is a like view of the positioning of the moving parts, when *upon further increase of exterior or diminution of interior pressure the valve-disk is forced to the fully open position."* (Emphasis ours)

In describing the operation of his device, Bruce, on page 2, beginning in line 10, stated:

> "In the operation of the device, it will be seen that *according to the vacuum created upon the outlet side of the valve, or an excess of pressure created upon the inlet side, the active member or disk-valve 4 will be drawn a greater or less extent toward the diminished end of 2,* against the tension of the spring 17 and thereby, due to the tapering member 14 gradually narrowing as it approaches the diminished portion of the shell 2, the opening between the active member 4 and the tapering member 14 will increase, and thus the air drawn in through the perforations 10, will be more or less freely drawn in therethrough, according to the size of the opening between the active member 4 and the tapering member 14, *which is determined by the variation of pressure,* and proportioned by the adjustment of the tapering member 14, by means of its positioning." (Emphasis ours)

Furthermore, in his claims, Bruce repeatedly refers to the disk member or valve as being "reciprocated upon the spindle *by variations in the pressure,* from the fully open to the fully closed position."

The undisputed testimony shows that the valve of the Bruce patent controls *rate* of flow in response to varying pressure differential and does not maintain a substantially constant pressure differential regardless of the rate of flow as does Appellant's valve. With more specific reference to the Record, Mr. Otis testified (Joint App. p. 60A) in response to a request that he state the purpose of the Bruce regulator:

> "The purpose of that regulator device very definitely is to regulate the rate of air intake or of flow by means of pressures already existing and existing independently of this tool, within and without the intake manifold."

Mr. Otis further testified (Joint App. p. 61A):

> "Its purpose was to regulate the rate of flow of air through its members in response to lowering of the pressure of the gasoline mixture within the manifold. It was simply a matter of regulating the flow, the rate of flow."

In response to a question as to whether the varying pressure differential within the manifold would or would not have existed without the Bruce valve, Mr. Otis stated (Joint App. p. 61A):

> "That pressure differential and the pressure variations would exist whether that valve was present or not."

Schramm testified on cross-examination (Joint App. p. 106A):

> "Bruce's purpose is evidenced almost immediately in the description of the long metering pin, that purpose being, this metering pin by being long, controls volume. It allows a small increase of the volume per unit movement of the spring. If he controls volume—now, mind you, he doesn't say how he maintains the constant volume, he controls volume, and by virtue of that, he cannot maintain a constant or substantially constant differential."

Without quoting further from the testimony, it is sufficient to state that it is all to the same effect and supports that portion of the Court's inconsistent finding to the effect that the Bruce valve controls flow in accordance with changes in the degree of vacuum. In view of this, the Bruce valve cannot maintain a constant pressure differential for varying rates of flow for that would be "lifting yourself by your own bootstraps."

It is clear that the District Court was confused in finding, without any shred of evidence in support thereof, that the Bruce patent valve would serve to maintain a constant differential in pressure, because if it would so serve, there would be no changes in pressure to which it could respond in its operation as stated in the patent and in the testimony, and as the Court found it would respond.

Therefore, it is respectfully submitted that the Court should have found that the Bruce patent valve would not operate to maintain a substantially constant differential of pressure between the ends of its casing for varying rates of flow.

Doubtless, the Court's confusion in this regard was caused by the apparent similarity in structure of the Bruce valve to the Otis regulator, because each employs fixed and movable valve elements and a spring acting on the movable valve element.

However, Bruce, desiring to make a regulator, which, as he states, will respond to varying pressures in order to regulate flow, provided a spring so proportioned with regard to the length of travel of his movable valve element that when his movable valve element is closed the spring will be more than twice as long as when the valve element is open. It is a well known scientific principle that the force exerted by a spring depends upon the degree of its compression. Hence, the Bruce spring when compressed to the open position as shown in Bruce's Fig. 4, would exert on the movable valve element a far greater force than it would when the valve element is in closed position as shown in Bruce's Fig. 2. In as much as it is the spring which determines the differential of pressures on the opposite ends of the Bruce valve, the differential in the Bruce valve, when that valve is fully open, would be much greater than when the valve is closed. Thus the valve would perform the purpose which Bruce intended for it and move to permit more or less flow in response to considerable variations in pressure.

The Otis regulator, on the other hand, has a movable valve element with a travel of only 1/16 of an inch from closed position to a position where it will permit the passage of 5,000,000 cu. ft. of gas per day. Yet it has a spring 7 inches in length so that the compression of the spring from the fully closed position of the Otis valve to its open position referred to would be less than one per cent (1%) of the length of the spring. (Joint App. pp. 99A, 100A) For all practical purposes the spring would exert the same force on the movable valve element throughout its intended range of movement. In other words, since the spring determines the differential, this differential in the Otis regulator would be in substance the same when the regulator is closed as when it is wide open. The regulator would maintain and, *according to the Court's finding,* does maintain a substantially constant pressure difference regardless of the well pressure or the extent of opening of the manual valve at the surface. (Joint App. p. 17A)

In view of these findings of the Court as to the operation of the Otis et al regulator and the finding as to Bruce which is supported by the Bruce patent and the evidence, it is submitted that the Bruce patent is not available either as a secondary reference against the combination claims or as a basic reference against the subcombination claims.

In view of the foregoing, it is additionally submitted that even if the Bruce valve were to be substituted for the manual bottom hole choke of Knowlton, such substitution would not produce the combination of the combination claims on appeal. This combination was found by the Court to comprise a surface choke in combination with a bottom hole choke or regulator automatically responsive to the adjustment of the surface choke to maintain a constant difference between the pressures immediately above and immediately below the bottom hole regulator, regardless of the extent of opening of the surface choke. The Bruce valve, according to the Court's finding and the patent, cannot maintain such a constant pressure difference.

As for the sub-combination claims the novelty lies in the concept of the combination with fixed and movable valve members of a means which acts upon the movable valve member to create and maintain a substantially constant pressure differential and not in the latter means per se. This combination provides a valve or regulator structure that, unlike the Bruce valve, will maintain a substantially constant pressure reduction across it for varying rates of flow.

That the difference between the two structures lies in the proportioning of the parts does not render the Appellant's structure unpatentable. In the case of *In Re Honger,* 33 C. C. P. A. 1158, 156 F (2) 183, the Court of Customs and Patent Appeals in 1946 had before it much the same sort of situation. The claimed structure distinguished from the structure of the reference by specifying that it had a certain mechanical advantage to produce a stated function. The reference was not clear as to whether its proportions were such as would give the necessary mechanical advantage, but it was clear that it was not intended to operate in the fashion of the claimed structure. The Court said,

> "The most that can properly be said of the Birkigt patent, so far as the issues here are concerned, is that it discloses a structure in which the parts

> *might* be so proportioned that the bolt would restore the locking device to its normal position. In the absence of any suggestion that such proportioning is desirable, the Birkigt disclosure is not a pertinent reference for claims calling for a structure in which the locking device is restored by the bolt."

In the present instance the Bruce patent does not suggest that the parts shall be proportioned in such a manner as to create and maintain a substantially constant pressure reduction for varying rates of flow. The patent actually intends and repeatedly expresses the intention that the valve should operate in a quite different manner and in response to variation in pressure, and the parts of his valve are clearly proportioned to so operate.

Therefore, it is respectfully submitted that the Bruce valve is not available as a reference against either the combination or the sub-combination claims on appeal.

## III.

The history of the art shows clearly that the problem of producing high pressure wells and dealing with the freezing which has troubled the industry, is one that has existed over a long period of years. (Affidavit of Knode, Joint App. p. 151A; Potter, Joint App. p. 22A). Various attempts have been made to solve it, including heating the flow lines from the wells at the points where the freezing tended to occur, (Joint App. pp. 23A, 45A, 84A, 85A) and providing various means for controlling the rate of flow and securing the consequent expansion of gas down in the well where the heat of the earth would be sufficient to prevent freezing. (Joint App. pp. 22A, 23A, 26A, 27A, 46A, 85A) The heater proved undesirable because of its initial and operational expense, and due to the inherent dangers accompanying the application of heat to conduits handling nautral gas under high pressure (Joint App. pp. 24A, 25A, 45A, 46A). All of the other arrangements which were used commercially served to limit the well to one rate of flow. (Joint App. pp. 22A, 23A, 46A, 85A)

The last attempt prior to the solution brought forward by the Appellant was that proposed in the Knowlton et al patent. This proposed solution proved a failure under extensive tests by persons who had every reason to want to make it work and every facility with which to try to make it work. (Joint App. pp. 113A, 114A, 123A). The apparatus failed to operate as intended and was junked (Joint App. pp. 119A, 120A) and the teaching has since reposed in the boneyard of abandoned hopes. The Patent Office Examiner attempted to resurrect it for the purpose of preventing the Appellant from obtaining a patent on that which has proved to be a successful solution to the problem. The Appellant and his co-inventor have found this solution by avoiding the route which most prior attempts followed, namely, that of controlling rate of flow down in the well, and instead, have controlled rate of flow at the surface where positive control can readily be maintained. This was made possible by the concept of placing a regulator down in the well, which does not interfere with variations in the rate of flow, but which automatically maintains a constant pressure reduction without regard to rate of flow, although separated by 3000 feet or more from the flow control.

The inventors took a different route, and though their change in physical equipment was not great, they produced a different result and achieved success. The use of the Otis et al regulator involved in this appeal, in 419 gas fields in the United States and abroad (Joint App. pp. 63A, 64A), is ample proof of its success and industrial acceptance. The accomplishment of the final act which included the ingredient of success where others had failed, is deserving of patent protection. The *Washburn and Moen Manufacturing Company et al.* vs. *The Beat'em All Barbed Wire Company et al.*, 143 U. S. 275; *Potts* vs.

*Creager,* 155 U. S. 597; *Diamond Rubber Co.* vs. *Consolidated Rubber Tire Co.,* 220 U. S. 428.

That the doctrine followed by the Supreme Court in the cases above cited is not dead is shown by that Court's opinion in the case of *Goodyear Tire and Rubber Co.* vs. *Ray-O-Vac Co.,* 321 U. S. 275, 279 (1944), in which Mr. Justice Roberts, speaking for the Court said:

> "Viewed after the event, the means Anthony adopted seem simple and such as should have been obvious to those who worked in the field, but this is not enough to negative invention. During a period of half a century, in which the use of flash light batteries increased enormously, and the manufacturers of flash light cells were conscious of the defects in them, no one devised a method of curing such defects. Once the method was discovered it commended itself to the public as evidenced by marked commercial success. These factors were entitled to weight in determining whether the improvement amounted to invention and should, in a close case, tip the scales in favor of patentability. Accepting, as we do, the findings below, we hold the patent valid and infringed."

## CONCLUSION

For the reasons hereinabove set forth, it is respectfully submitted that the Decree of the District Court should be reversed and the cause remanded with instructions to authorize the issuance of the patent sought by Appellant.

Respectfully submitted,

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James B. Simms

# BRIEF FOR APPELLEE

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# United States Court of Appeals

## FOR THE DISTRICT OF COLUMBIA CIRCUIT

Appeal No. 10,683

HERBERT C. OTIS, APPELLANT

*v.*

JOHN A. MARZALL, COMMISSIONER OF PATENTS,
APPELLEE

*APPEAL FROM THE JUDGMENT OF THE UNITED STATES DISTRICT COURT FOR THE DISTRICT OF COLUMBIA*

**E. L. REYNOLDS,**
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United States Court of Appeals
For the
District of Columbia Circuit

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Joseph W. Stewart
CLERK

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# United States Court of Appeals

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*APPEAL FROM THE JUDGMENT OF THE UNITED STATES DISTRICT COURT FOR THE DISTRICT OF COLUMBIA*

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## BRIEF FOR APPELLEE

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### INTRODUCTION

This is an appeal from the judgment of the United States District Court for the District of Columbia (19A)[1] dismissing the complaint in an action under R. S. 4915 (U. S. C., title 35, sec. 63) in which the appellant sought to have the Court authorize the issuance to him of a patent containing seventeen claims of the application of Otis and Luccous, Serial No. 473,838, for patent on a valve mechanism for use in controlling the flow of well fluids. The claims were rejected as failing to define invention over certain prior patents.

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[1] The numbers in parentheses refer to pages of the joint appendix.

## APPELLANT'S APPLICATION

The appellant's application here involved discloses a fluid well system in which a manually adjustable valve is located in the outlet pipe, adjacent the ground level, and an automatic valve is placed in the outlet pipe near the bottom of the well. The automatic valve comprises a fixed valve element and a sleeve, connected to and communicating with the outlet pipe and movable toward and from the value element to regulate the flow of fluid into that pipe. The sleeve is urged toward the valve element by a spring and is exposed on its upper end to the pressure in the outlet pipe and on its lower end to the pressure of the fluid in the well. The valve mechanism acts to maintain a constant difference between the pressure immediately above and the pressure immediately below the valve, regardless of the well pressure or the extent of opening of the manual valve at the surface.

## THE REFERENCES

The patent to Knowlton et al. No. 1,905,592 (158) discloses a control system for fluid wells comprising a manually operable valve located in the outlet pipe at the ground level and a second valve, located in the outlet pipe near the bottom of the well and manually controlled from the ground level. The patent states that the arrangement disclosed "makes it possible to obtain a pressure differential between the well and the inside of the tubing ranging from zero to the maximum formation pressure."

The patent to Bruce No. 1,199,152 (154) discloses an automatic flow regulating valve comprising a casing containing a fixed tapered projection and a movable piston member having an opening surrounding the projection, so that the movement of the member varies the size of the fluid passage between it and the projection. The movable member is urged by a spring toward valve-closing position and is acted upon on one side by the fluid entering the casing and on the other side by the fluid which is leaving the casing after passing the valve. The arrangement thus provided serves to maintain a constant differential in pressure between the inlet and outlet ends of the casing. The device is shown only in connection with an internal combustion engine for admitting supplementary air from the atmosphere into the intake manifold in accordance with changes in the degree of vacuum existing in the intake manifold from time to time, but is said to be useful for regulating the flow of "all fluids."

The patent to Otis, No. 1,920,103 (163) discloses a choke device having restricted passage which device may be lowered into and anchored in a fluid well to produce a pressure drop for a predetermined constant rate of flow in the outlet pipe. The device may be removed and replaced by another having a passage of a different size, if it is desired to produce a different pressure drop. The exchange of restrictions requires extensive operations while the well is shut in, as fully set forth in the patent.

## APPEALED CLAIMS

The appealed claims appear on pages 4A to 11A, inclusive, of the joint appendix.

## SUMMARY OF ARGUMENT

1. The appellant's valve structure is substantially identical, in construction and operation, with that of the Bruce patent.

2. Appealed claims 40, 41, 44, 46, 48, 49, and 50 are clearly unpatentable over Bruce alone.

3. The Knowland et al. patent discloses the same general combination as the appellant's application, except that the patented structure employs a manually operated valve in the bore hole instead of an automatic one.

4. It would not require invention to replace the manual valve of Knowland et al. by the equivalent automatic valve of Bruce.

5. The use of two or more valves such as are shown by Bruce in the same bore hole would be an obvious expedient.

## ARGUMENT

The claims involved in this appeal may be divided into two groups, namely, claims 40, 41, 44, 46, 48, 49, and 50, drawn to a pressure regulating valve structure, and the remaining claims, drawn to that structure in association with a fluid well system. These two groups should be treated separately. The claims of the former group are considered unpatentable over the Bruce patent alone and, in considering them, it is desirable to compare the regulating valve, which is the essential feature of all the appealed claims, with the regulating valve of the Bruce patent.

In comparing the two valves Fig. 3 of the Bruce patent (154) should be inverted and placed beside appellant's Fig. 3. It will then be seen that each valve structure includes a cylindrical casing, 10 in appellant's structure and 1 in that of Bruce. A perforated plug or disk, 12 in appellant's device and 8 in Bruce's, is threaded into one end of the casing, and tapered valve members (20, 20′) and 14, respectively, are threaded into the disks. Cooperating with the tapered valve, in each case, is a sleevelike element associated with a piston which slides in the cylindrical casing. In appellant's structure 22 is the sleeve and 24 the piston while in the Bruce patent 4 is the piston and the annular flange in the center of the piston and surrounding the tapered valve member 14, is the sleeve. Each sleeve member and piston are urged by a spring toward a position in which the sleeve engages the tapered member and closes the fluid passage through the casing. In appellant's structure 28 is the spring and in Bruce's it is 17. Each structure is provided, at the end of the casing opposite the valve member, with a fluid outlet passage.

Since the two structures are thus substantially identical, it is evident that the method of operation must be the same in each case, and that the Bruce valve therefore satisfies the operation set forth in the appealed claims. By way of example claim 49, which is typical of the rejected claims of the first group, may be applied to the device of the Bruce patent as follows:

The claim begins by referring to the device as a "well fluid regulator for a flowing well," and the fluid is later referred to as "well fluid." It is well settled, however, that a claim to a device must distinguish from the prior art by a positive recitation of structure, and that an introductory reference to the intended purpose for which the device is to be used is not a limitation on the claim, and should be disregarded (*Braren* v. *Horner,* 47 F. 2d 358, 18 C. C. P. A. 971 and authorities there cited; *In re Waldron,* 117 F. 2d 381, 28 C. C. P. A. 862; *In re Dawe,* 19 C. C. P. A. 728, 53 F. 2d 543; *In re Wolfe,* 69 F. 2d 550, 21 C. C. P. A. 974; *In re Stacy,* 135 F. 2d 232, 30 C. C. P. A. 972). Moreover, Bruce specifically points out in the paragraph beginning in line 20 on page 155 of the appendix that his device may be used "to automatically regulate the flow of all fluids," which, of course, would include well fluid and finally, even if he had not made that statement, the broad idea of applying his device to a well would be obvious, as the lower court held in its seventh finding of fact (18A). Accordingly in considering the claims of the first group, the references to a well may be ignored as being of no patentable significance. Similarly, it is immaterial whether the fluid flows "upwardly" through the device or not, since the position in which the valve is used is merely a matter of choice.

Claim 49 calls for a regulator including a body having a fluid inlet and a flow passage from the inlet through the body. In Bruce, 1 is the body, orifices 10 provide the fluid inlet and the interior of the body 1 forms the flow passage. The valve members next called for by the claim are the parts 4 and 14 of Bruce, the member 4 having its opposite ends exposed to fluid pressures acting upwardly and downwardly (when the device is used in a vertical position). The spring 17 is a resistive means urging valve member 4 toward member 11. This is the only structure recited, the remainder of the claim being devoted to a functional statement. Such a statement cannot render a claim patentable if the actual structure recited is old. This was definitely stated by the Supreme Court of the United States in *General Electric Co.* v. *Wabash Appliance Corp. et al.,* 304 U. S. 364, in which case the Court held that "a claim describing nothing new except perhaps in functional terms" could not be patentable. The same principle has been repeatedly applied by other courts (*In re Stattmann,* 146 F. 2d 290, 32 C. C. P. A. 813; *Gynex Corp. et al.* v. *Dilex et al.,* 85 F. 2d 103; *Bituminous Products Co.* v. *Headly,* 2 F. 2d 83; *In re Griswold,* 152 F. 2d 1014, 33 C. C. P. A. 799). In the first-cited case, this principle was said to be "so elementary that it is not necessary to cite authorities."

It follows that claim 49 is anticipated in every material respect by the Bruce patent, and this is similarly true of claims 40, 41, 44, 46, 48, and 50, the remaining claims of the first group. Those claims have not been discussed individually by the appellant and it is thought to be unnecessary to do so here. The reference in claim 50 to means for securing the device "in a well tubing below the surface of the well" adds nothing material to the claim since the screw threads 2 of the Bruce device would serve this purpose.

For the reasons given above, it is immaterial, so far as the first group of claims is concerned, whether or not the Bruce valve functions in the same manner as appellant's. The appellant is not entitled to repatent the Bruce device merely by ascribing a different function to it. However, the function is material in connection with the claims of the second group and accordingly it will now be shown that the Bruce device does function in the same manner as that of the appellant, namely, to maintain a constant differential between the pressure immediately above and below the valve.

It is noted that in appellant's brief, page 11, it is alleged that the lower court's holdings that the Bruce valve will maintain a constant pressure differential and that it will admit air in accordance with changes in the degree of vacuum in the intake manifold are inconsistent, and on page 12 of the brief it is stated that a valve cannot serve "to maintain a constant differential in pressure—in accordance with changes in the degree of vacuum." This is a misquotation of what the lower court held. The holding was not that the pressure differential accorded with changes in the degree of vacuum in the manifold, but that the air admitted varied in this manner, which is an entirely different matter. The amount of air admitted depends not only on the pressure differential but also on the size of the valve opening. In the Bruce device, while the pressure differential remains constant the size of the valve opening varies with the degree of vacuum in the intake manifold. Thus the amount of air admitted varies with the vacuum as correctly held by the lower court.

The similarity of appellant's device and that of Bruce has already been pointed out and it seems clear that devices so nearly identical in structure could not differ materially in operation. While the appellant's brief vigorously contends that there is a material difference, the contention rests on little more than ex-cathedra assertion. The brief, especially on pages 28 and 29, appears to confuse pressure with pressure difference. In the present case, the two are entirely independent. For example, if the pressures on opposite sides of the valve are one and two pounds per square inch respectively, or minus ten and minus nine, or one hundred and one hundred and one, the differential is exactly the same in each case. It is thus entirely possible to maintain a constant differential while varying the absolute pressure on the outlet side of the valve and, in fact, such variations occur in appellant's structure as well as in Bruce's. If they did not the device would be useless, since its purpose is to deal with varying pressure conditions. Accordingly Bruce's statements that the pressure on one side of his valve varies are irrelevant here. He does not state that the pressure differential between the sides of his movable valve member varies, which is what the appellant is seeking to show.

Referring to Fig. 3 of Bruce (154), it will be obvious that the only force tending to move the member 4 downwardly of the page, toward open position, is the fluid pressure above the member, while the member is urged upwardly by the pressure below it and by the force of the spring 17. When the valve is at rest in any position intermediate the ends of the casing, which would be its normal condition, the forces on opposite sides of member 4 are equal. The differential in fluid pressures, therefore, will be equal to the force exerted by the spring 17. If now the pressure below the member 4 decreases, the forces acting on it will be unbalanced and the member will move down, opening the valve farther and admitting more air to the manifold, which will tend to raise the manifold pressure and restore the valve to its original position. In any operative position of the valve the pressure differential between the sides of member 4 will be equal to the force exerted by the spring 17. This is exactly the operation of appellant's valve also.

No regulating system of the kind here involved can maintain an exact condition of equilibrium, since it is necessary that there be some change before the regulating means can act. Further, the resistance of any coil spring of finite length will vary somewhat as the spring is compressed or expanded. Accordingly, the reference in the claims to the maintaining of a constant pressure differential can mean only that this condition is approximated, which is true in Bruce's structure as well as in appellant's.

On cross-examination (70A et seq.) the appellant conceded (71A) that the Bruce valve will tend to maintain a constant pressure differential, but sought to distinguish that valve from his in terms of the length of the spring and the taper of the fixed valve member. He appeared to concede (72A) that these were the only material differences between the two. It is obvious, however, that these are differences in degree only. A long spring will tend to keep the differential more nearly constant than a short one will, but, as above pointed out, neither is perfect and both are effective to some extent. The same is true of the taper of the valve.

It is highly significant, moreover, that the appealed claims are completely silent as to the length of the spring or the taper of the valve. In other words the distinctions which the appellant, in his testimony, alleges to be critical, are not even hinted at in the claims. The case, therefore, would seem to be governed by *Seyforth* v. *Coe,* 76 U. S. App. D. C. 96, 129 F. 2d 58 in which this Court said:

> For want of sufficient description of the invention in the only claim now before us, the judgment of dismissal must be affirmed. We are not at liberty, as appellant suggests, to fill out the deficiency in the claim by reference to the application or to other claims not before us.

The appellant's position in the present case is even weaker than in that last cited in that the application itself contains no statement as to how long the spring should be or how sharply the fixed valve member should taper. In effect, therefore, the appellant is seeking a patent on the basis of proportions which, at best, are disclosed indefinitely in diagrammatic drawings, and which are not included in his claims.

It is submitted that if, as alleged, the proportions of the spring and valve are critical, they should have been included in the claims and that, not having seen fit to limit the claims in this respect, the appellant should not be allowed to predicate patentability on those features.

The claims of the second group, so far as they relate to the regulating valve, are no more specific than those of the first group. Accordingly, for the reasons given, it will be considered that the regulating valve of Bruce is the full equivalent so far as those claims are concerned, of that of the appellant. The claims now to be considered differ from those of the first group in that they are not drawn to the regulating valve, per se, but to a well system in which that valve is placed in the well and an additional control valve is located at the surface. With this arrangement the pressure drop in the well is kept constant, thus avoiding the danger of freezing, while the rate of flow is controlled by the surface valve.

The Knowlton et al. patent (158) shows the appellant's combination of a fluid well with adjustable valves in the well and at the surface. The patent states in line 110 et seq. on page 161 of the appendix that the valve in the well may be adjusted to provide any desired pressure differential between zero and the maximum formation pressure, and that, with such pressure differential "it is apparent that perfect control of flowing conditions are obtained." One of the objects of such control, as described on the first page of the patent, is the prevention of freezing. Obviously, therefore, the Knowlton et al. patent contemplates the control of a manually regulated valve in the well in such a manner as to prevent freezing.

This, of course, means that the aim of the manual regulation will be to keep the pressure differential on opposite sides of the valves substantially constant, since this drop should be kept uniformly as high as it can be without freezing. It is evident, therefore, that Knowlton et al. were seeking to accomplish by manual regulation what the appellant seeks to do by automatic regulation. This was substantially conceded by the appellant himself in answer to the last question on cross-examination (75A).

The Bruce patent, as above pointed out, shows an automatic valve for accomplishing the same regulation which Knowlton et al. accomplish manually, and the Bruce valve is of general application and could obviously be so proportioned as to be suitable for use in a well. The second group of claims, therefore, call for no more than the use of an old automatic valve to perform the function previously accomplished by a manual valve. The only result produced by this substitution is that which would normally be expected in such a case, namely, convenience and more even regulation. It is therefore submitted that the lower court's holding that the substitution involved no invention was correct. It is well settled that the substitution of an old automatic control for a manual one is not ordinarily a matter of invention (*Cuno Engineering Corp.* v. *Automatic Devices Corp.*, 314 U. S. 84; *McCarthy et al.* v. *National Perforator Co., Inc.*, 5 Fed. Supp. 210, 20 USPQ 204, *In re Rundell*, 48 F. 2d 958, 18 C. C. P. A. 1290).

The appellant seeks to overcome the Knowlton et al. patent as a reference by contending that it is inoperative. It is well settled that a patented device is presumed to be operative and that one asserting the contrary has the burden of showing not only that the exact thing shown by the patent will not operate, but that it could not be made operative by the exercise of ordinary skill (*Keystone Type Foundry* v. *Fastpress Co.*, 263 F. 99; *Manhattan Book Casing Machinery Co.* v. *E. C. Fuller Co.*, 274 F. 964; *Remington Cash Register Co.* v. *National Cash Register Co.*, 6 F. 2d 585; *Radio Corporation of America* v. *Edmond*, 20 F. 2d 929, *Trumbull* v. *Kirschbraun*, 67 F. 2d 974, *Kamborian* v. *United Shoe Machinery Corp.*, 73 F. S. 548). Further, the fact that a device has not been used commercially or that it is cumbersome or difficult to use does not establish that it is inoperative (*Underwood* v. *Typewriter Inspection Co.*, 177 F. 230; *Sun Ray* v. *Bellows*, 49 F. 2d 886; *Barber Colman Co.* v. *Withnell*, 14 F. 2d 780; *Fox* v. *Corona*, 282 F. 502).

The evidence relied on by the appellant falls far short of meeting the requirements laid down by these decisions. Even giving it the interpretation most favorable to the appellant's contention it does no more than show that one experiment with the Knowlton et al. device encountered some difficulties and was not followed by commercialization. The assertion in appellant's brief, page 19, that "the equipment was junked" is an overstatement of the testimony. The witness Knowlton merely said (120A): "Well, as far as I know they were both disposed of as junk. In other words, they were not used to my knowledge after these tests were completed." However, even assuming that the particular equipment referred to was junked, that would not establish that the patent disclosure is inoperative or that it could not be made to operate by a skilled mechanic. It would merely show that, for some reason, the device was not suitable for commercial use.

Actually, as brought out in the cross-examination of Knowlton, the trouble was merely that it proved difficult to regulate the device satisfactorily by hand. This is summed up in Knowlton's testimony on page 123A in which he was asked "Isn't that just a matter of skill of the operator?" and answered "Well, yes, but it is very difficult to keep changing that back and forth and getting a proper regulation——." Obviously, mere difficulty in operation is far from actual inoperativeness.

Moreover, even if the Knowlton et al. patent could be held to disclose an inoperative device, it obviously teaches the idea of combining a surface control with a regulating valve located in the well, and this would suggest trying other regulating valves if the particular one illustrated was found unsatisfactory. The type of valve shown by Bruce would naturally suggest itself as suitable.

For the reasons given, it is submitted that the lower court correctly held that the claims of the second group define merely an obvious modification of the Knowlton system in view of Bruce. If this is true, the fact, if such it be, that appellant obtained results considerably superior to those of the Knowlton et al.

system does not entitle him to a patent (*Standard Oil Development Co.* v. *Marzall,* U. S. App. D. C. Appeal No. 10,026, decided February 27, 1950, 84 USPQ 363).

Some of the claims, as for example claim 62, call for a plurality of valves in the well. This is an obvious duplication in which each valve continues to perform its old function and the total result is the sum of those functions. Accordingly, if the use of one such valve involves no invention there would be no invention in using two or more. Appellant has not discussed the claims of the second group in detail and such detailed consideration therefore seems unnecessary here.

## CONCLUSION

It is submitted that appellant's automatic regulating valve is fully met by the Bruce patent; that the claimed combination of surface and well regulating valves is old in Knowlton et al. and that no invention would be involved in replacing the manual well valve of Knowlton et al. by the equivalent automatic valve of Bruce. The record, therefore, clearly supports the lower court's holding that the appealed claims are unpatentable and the decision below should be affirmed as to all the appealed claims.

Respectfully submitted.

E. L. Reynolds,
*Solicitor, United States Patent Office,*
*Attorney for Appellee.*

September 1950.

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United States Court of Appeals
For the
District of Columbia Circuit

FILED APR 27 1951

Joseph W. Stewart
CLERK

IN THE

# United States Court of Appeals

FOR THE DISTRICT OF COLUMBIA CIRCUIT

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HERBERT C. OTIS, *Appellant*,

v.

JOHN A. MARZALL, Commissioner of Patents, *Appellee*.

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## APPEAL NO. 10,683

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## PETITION FOR REHEARING

COMES NOW the appellant and petitions this Honorable Court for a rehearing in the above-entitled cause on the following grounds:

The Court in its opinion based its decision upon an understanding different from that intended by appellant as to what constituted the inventive concepts involved in the claims on appeal.

a. The inventive concept in the bottom hole regulator claims is the basic idea that in order to provide the specific type of automatic regulation desired, a means was needed which would exert *a uniform closing force* on the movable valve element *throughout the range* of its expected movement. It is this concept that Bruce fails to disclose or suggest. The portion of Appellant's testimony quoted in the Court's opinion was in response to the last two preceding questions, which assumed that the skilled mechanic would be given both the Bruce patent *and the concept* of a valve to maintain a constant differential. The invention is not in the length of spring or the degree of taper of the stationary valve element, which are admittedly within the skill of an ordinary mechanic, once the basic concept has been produced.

b. The inventive concept in the combination claims does not consist in providing automatically the same regulation down in the well that Knowlton sought to provide manually. The inventive concept is that *a specific type of regulation, different from any provided or sought by Knowlton, should be provided* in combination with a surface control; namely, a regulation which would produce a substantially *constant* pressure reduction for varying rates of flow. For example, the regulation desired was to be such that if it produced a pressure reduction of 1500 pounds per square inch down in the well when the well flows at the rate of 5,000,000 cubic feet per day, it would also produce substantially 1500 pounds per square inch differential in pressure down in the well when the well flows not at all, and substantially the same pressure reduction when the well flows at all intermediate flow rates. Knowlton does not suggest the desirability of such a specific type of regulation, either manually or otherwise.

## FACTUAL BASIS FOR THIS PETITION

1. In the Court's opinion, the Court, after referring to the fact that in the regulator claims nothing is said concerning the length of spring nor the angle of taper of the fixed valve member, says

> "yet it is upon these two factors (together with massiveness of design) that he chiefly relies in distinguishing his invention from Bruce",

whereas in appellant's brief, page 33 at the beginning of the first full paragraph, it is stated

> "As for the subcombination claims the novelty lies in *the concept of the combination* with fixed and movable valve members of a means which acts upon the movable valve member to create and maintain a substantially *constant* pressure differential *and not in the latter means per se.*" (Emphasis added)

2. The Bruce valve, as stated in the Bruce patent, was designed to deal with situations in which *the pressure reduction between its inlet and outlet was not constant but varying.* (Page 1, lines 9-15 of Bruce patent). The appellant's desired regulation was to maintain the pressure reduction constant.

3. The invention as to the regulator lay in the conception of the idea that the desired regulator that would maintain *a substantially constant pressure reduction for varying rates of flow could be produced by utilizing a means urging the movable valve member toward closed position with a force substantially constant regardless of rate of flow.*

4. In the appellant's testimony quoted in the Court's opinion, and in the testimony of the witness Schramm, (Joint Appendix, page 102-A, beginning about the middle of the page and continuing to the first answer on page 103-A), it is clear that once the inventive concept stated had been arrived at by the inventors, a skilled mechanic could design the required spring or other force applying biasing means.

5. In the Court's opinion during the discussion of the claims dealing with the combination of a surface control valve with the pressure reduction regulator down in the well, the Court stated,

> "True, Knowlton's controls were both manual while appellant's sub-surface control is automatic."

and the remainder of the opinion makes it apparent that the Court believed that all Otis and Luccous had done was to do automatically what Knowlton sought to accomplish manually in the way of sub-surface regulation.

6. In the appellant's brief on page 5, it is stated

> "It is noted that all the attempts which took advantage of the earth's heat to prevent freezing, employ, down in the well, a means which would limit the flow from the well and none had the concept of reducing pressure down in the well by a *constant* amount without limiting flow, and independently of flow. By contrast, the concept of this invention is to take advantage of the earth's heat to avoid freezing by employing in the well a device which will not limit the flow *but will affect a predetermined pressure reduction without regard of rate of flow.*"

## ARGUMENT

> "The rule has been so often stated and is so well understood as to call for no citation of authorities that the assembling into a new article of a number of good features of the prior art may involve invention and be of such utility and produce such unexpected results as to be patentable. The conception of a structure of that character may be the invention, even though the assembling of it into a united structure would involve little more than mechanical skill after such conception. Hayes, 'A Definition of Invention', 1941, p. 17; *Hobbs* v. *Beach,* 180 U. S. 383, 21 S. Ct. 409, 45 L. Ed. 586; *in re Hofmann,* 95 F. 2d 257, 25 C. C. P. A. (Patents) 975; *in re Bencker,* 96 F. 2d 326, 25 C. C. P. A. (Patents) 1097." (*In re Holt,* 162 F. (2) 472, CCPA 1947).

In the case at bar the inventors had before them a situation in which the prior attempts to solve the problem had, as the Court has stated, proceeded along the line of utilizing some type of sub-surface regulation in order to obtain a reduction of pressure down in the well where the earth's temperatures were high enough to prevent freezing. Among these was Knowlton who proposed a variable type of regulation down in the well. The Court has held that no invention would be involved in substituting for the Knowlton bottom hole valve an automatic regulator down in the well. But the inventive concept of Otis and Luccous went much farther than merely the provision of automatic regulation where Knowlton had provided manual regulation. The Otis and Luccous concept as set forth in the claims on appeal, contemplated a specific type of regulation, namely, a regulation which would not merely provide a pressure reduction down in the well, but which would provide a *substantially constant* pressure reduction down in the well regardless of rate of flow. This concept is wholly absent from the Knowlton disclosure and neither Knowlton nor any other prior art suggests that the solution to the problem would lie in keeping the pressure reduction down in a well substantially constant for all rates of flow.

Once this concept was reached, it is true, as the Court has stated, that if a regulator were available which would provide such a constant pressure reduction during variations in rate of flow, the mere placing of such a valve down in the well would not involve invention. It is submitted, however, that the concept that there should be a means in the well for maintaining the pressure reduction substantially constant for all rates of flow is one far beyond the skill of even a skilled mechanic such as Knowlton and is deserving of patent protection, even if such a regulator had been available for use.

The inventors in this instance were faced with a further problem even after arriving at the inventive concept above stated. There was no valve available in the prior art which would maintain a substantially constant pressure reduction for varying rates of flow and which was of such a nature that it could be used down in a well. The Bruce valve was for use under varying pressures and not to maintain a constant pressure. The inventors were thus faced with providing a regulator which would produce the kind of regulation they were after.

The inventive concept of the regulator claims is that if a structure were provided employing a stationary and a movable valve element in combination with a means which would urge the movable valve element toward a closed position with a substantially constant force regardless of the position of the movable valve element within its intended range of movement, a regulator would result which would provide the results sought.

Once this concept was arrived at, it became the work of a skilled mechanic to design the length of the spring and the taper of the valve element. In addition to Mr. Otis' testimony quoted by the Court to the effect that the length of spring was within the capacity of a good mechanic, and Schramm's testimony above cited to the effect that his engineers, called upon to produce a regulator in accordance with Claim 40, (which refers to the spring only as a means acting on the movable valve element to resist movement of said element to create a predetermined flowing pressure differential thereacross) could produce such a regulator, it is within the judicial knowledge of the Court that other means were available for exerting a substantially constant force against the movable valve member. For example, if the regulator were so arranged that the movable valve member would move downwardly in moving toward closed position, a sufficient weight placed upon the movable valve member would exert a substantially constant force on such member tending to close it.

Thus, it was not the design of the spring or other means for exerting the substantially constant closing force on the movable valve member that involved invention, but rather the concept provided by Otis and Luccous and set forth in the claims on appeal that such a means should be provided in combination with the other elements of the regulator.

In view of the foregoing, it is respectfully submitted that these inventors have made a patentable invention in that (1) they did not merely do automatically what Knowlton sought to do manually, but arrived at a concept providing a specific type of regulation which was different in kind and beyond the skill of the expert Knowlton and resulted in practical success long after Knowlton's attempt had been cast aside, and (2) they made a further patentable invention in arriving at the concept that a valve could be produced which would provide a regulation of the desired nature by combining with fixed and movable valve elements a means for exerting a constant closing force on the movable valve element, which concept is completely lacking in the Bruce patent.

Reconsideration and reversal of the Court's judgment is respectfully solicited.

Respectfully submitted,

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## CERTIFICATE OF GOOD FAITH AND OF SERVICE

I certify that the foregoing Petition for Rehearing is presented in good faith and not for delay; and that said petition was served upon E. L. Reynolds, Solicitor for the Commissioner of Patents, by handing copies thereof to him at the Patent Office.

/s/ George Rex Frye